INFANT FEEDING PRACTICES AND SUBSEQUENT CHILDHOOD OBESITY AMONG HISPANIC AND NON-HISPANIC INFANTS AND CHILDREN SERVED BY THE SPECIAL SUPPLEMENTAL NUTRITION PROGRAM FOR WOMEN, INFANTS AND CHILDREN IN INDIANA BETWEEN 2008 AND 2012

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ABSTRACT

THESIS: Infant Feeding Practices and Subsequent Childhood Obesity among Hispanic and Non-Hispanic Infants and Children Served by the Special Supplemental Nutrition Program for Women, Infants and Children in Indiana Between2008 and 2012

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Childhood obesity remains a public health issue, with Hispanic children having the highest prevalence rates of childhood obesity in the United States and among those served by the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Current literature suggests the method of infant feeding may be associated with an increased risk of childhood obesity, especially among Hispanics. Thus, the purpose of this secondary data analysis was to determine the relationship between infant feeding practices and the subsequent classification of obesity among Hispanic and non-Hispanic children 2 to 5 years of age served by the WIC program in Indiana between 2008 and 2012. The initial dataset, obtained from the Indiana State Department of Health, included records for 1,205,384 visits from 225,827 unique individuals. After removing all outliers, excluding all low birth weight infants, and delimiting the data to single-race infants who were designated as either Hispanic or non-Hispanic and who remained in the WIC program into at least their second year of age, the dataset was reduced to 117,846 individuals with an average of 5.3 WIC visits. Type of infant feeding (i.e., ever breastfed, partial breastfed, formula fed) was abstracted from the data set. Percent weight for height by gender and age was calculated for each visit. Results indicated that 64.7% of WIC

participants in Indiana were ever breastfed, lower than the *Healthy People 2020* goal of 81.9%. One-fifth (21.6%) of the participants were subsequently categorized as obese (BMI of 95th percentile or higher for age and gender) at least once between their second and fifth birthday during the time they were enrolled in WIC. The length of time a child breastfed was significantly shorter for those categorized as obese (2.8 ± 5.6 months) compared to those who subsequently never became obese (3.5 ± 6.4 months) ($p < 0.001$). Hispanic participants who were never breastfed had higher obesity rates (30.9%) compared to non-Hispanics (21.7%), with the odds of becoming obese increasing by 38% if the child was Hispanic. In contrast, for each month a child breastfed, their odds of becoming obese dropped by 1.5%. The results of this study contribute to the emerging literature by examining infant feeding practices and the subsequent odds of becoming obese among WIC participants in Indiana and will enable health professionals to promote breastfeeding as an appropriate and safe feeding practice to reduce the odds of obesity.

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CHAPTER 1

INTRODUCTION

Current recommended infant feeding practices (i.e., initiation of breastfeeding upon birth, exclusively breastfeeding up to 6 months, initiation of complementary feeding at 6 months, and continuing breastfeeding into the second year), have not varied significantly over the past 40 years (Kleinman, 2014).Studies have shown the potential link between infant feeding practices in the first two years of life and health status in both childhood (Whaley et al., 2014) and adulthood (Muniandy, Allotey, Soyiri, & Reidpath, 2016; Stuebe & Schwarz, 2010).Infant feeding practices play a role in the weight status of infants and children (Valencia et al., 2016.) Breastfed infants having a reduced risk of becoming obese between the ages of 2 and 5 (Whaley, Ritchie, Spector, & Gomez, 2012), with a longer breastfeeding duration associated with a reduced risk of gaining excessive weight (Sinigaglia, Ríos, Campos, Díaz, & Palacios, 2016).

National Health and Nutrition Examination Survey (NHANES) data from 2011-2014 estimated that 8.9% of children 2 to 5 years of age are obese (Ogden, Carroll, Fryar, & Flegal, 2015). Childhood obesity has been liked to immediate and long-term adverse health outcomes, including sleep apnea, hypertension, heart disease, stroke, early onset of type 2 diabetes mellitus, osteoarthritis and certain types of cancer, and leads to psychosocial problems such as stigmatization and poor self-esteem (An, 2017). Disparities in the prevalence of childhood obesity by race and ethnicity exist, with 2011-14 NHANES data indicating 21.9% of Hispanic

children aged 2 to 19 years were obese, higher than the rate among non-Hispanic blacks (19.5%) and non-Hispanic whites (14.7%) (Ogden, Carroll, Lawman, Fryar, Kruszon-Moran, Kit, & Flegal, 2016).

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is a federal program administered by the Food and Nutrition Service of the U.S. Department of Agriculture. The purpose of WIC is to safeguard the health of low-income (185% of the federal poverty guidelines or less) women, infants, and children up to age 5 years who are at risk for poor nutrition by encouraging breastfeeding and providing supplemental, nutritious foods, nutrition education, and referrals to health care and other social services (Schultz, Byker Shanks, & Houghtaling, 2015). The WIC program is offered in each of the 50 States, the District of Columbia, 5 territories (American Samoa, Guam, the Northern Mariana Islands, Puerto Rico, and the Virgin Islands), and 34 Indian tribes (Thorn et al., 2015). In 2014, over nine million women, infants, and children participated in WIC; of these, 41.6% reported being Hispanic/Latino (Thorn et al., 2015).

In 2014, 14.5% of the WIC participants aged 2 to 4 years were categorized as obese (Pan, Freedman, Sharma, Castellanos-Brown, Park, Smith, & Blanck, 2016), with the prevalence of obesity among Hispanic children (17.3%) higher than all other races. Limited data exists, however, that examines the effect of breastfeeding on the risk of childhood obesity across race and ethnicity (Ehrenthal, Wu, & Trabulsi, 2016). Understanding how early dietary practices relate to weight status in infants may help guide the development of programs to prevent obesity later in life (Sinigaglia et al., 2016). Thus, assessing the relationship between infant feeding practices and childhood obesity, particularly among Hispanic children who have the highest rate of obesity in the United States, is warranted.

Problem Statement

Current recommended infant feeding practices include initiation of breastfeeding upon birth, exclusively breastfeeding up to 6 months, initiation of complementary feeding at 6 months, and continuing breastfeeding into the second year (Kleinman, 2014). Consistent overnutrition (i.e., excess consumption of calories), however, can result in childhood obesity, an increasing public health concern (Wojcicki et al., 2012). Recent National Health and Nutrition Examination Survey (NHANES) data (2011-2014) indicated 8.9% of children 2 to 5 years of age have obesity (Ogden et al., 2015), with the rate of highest (21.9%) among Hispanic children aged 2 to 19 years old (Ogden et al., 2016). Infant feeding practices play a role in the weight status of infants and children (Valencia et al., 2016), with breastfed infants having a reduced risk of being obese between the ages of two and five years (Whaley et al., 2012). Few studies have examined the effect of breastfeeding on the risk of childhood obesity across race and ethnicity (Ehrenthal, Wu, & Trabulsi, 2016). Understanding how early dietary practices relate to weight status in infants by race and ethnicity will help dietitians develop culturally sensitive programs to prevent obesity later in life (Sinigaglia et al., 2016). Thus, assessing the role infant feeding practices play in childhood obesity, particularly among Hispanic children who have the highest rate of obesity in the United States, is warranted.

Purpose

The purpose of this study was to determine the relationship between infant feeding practices and the subsequent classification of obesity among Hispanic and non-Hispanic children 2- to 5-years of age served by the WIC program in Indiana between 2008 and 2012.

Research Questions

The following research questions will be examined in this study:

RQ#1. What is the relationship between method of infant feeding and the subsequent classification of having obesity among children 2- to 5-years of age served by WIC in Indiana between 2008 and 2012?

a) Among infants who were "ever breastfed"?

b) By length of time (duration) an infant was exclusively breastfed?

c) By type of infant feeding practice (i.e., fully breastfed, partially breastfed, or fully formula fed)?

RQ#2. Is there a difference between the method of infant feeding and the classification of having obesity among children 2- to 5-years of age served by WIC in Indiana between 2008 and 2012 by ethnicity (Hispanic vs. non-Hispanic)?

a) Among infants who were "ever breastfed"?

b) By length of time (duration) an infant was exclusively breastfed?

c) By type of infant feeding practice (i.e., fully breastfed, partially breastfed, or fully formula fed)?

RQ#3. Can the onset of obesity between the ages of 2 and 5 years be predicted based on the type of infant feeding practice among Indiana WIC participants between 2008 and 2012 by race/ethnicity?

a) Overall

b) By ethnicity (Hispanic vs. non-Hispanic)

Rationale

The increase in obesity during childhood has become an important public health concern in the United States (Wojcicki et al., 2012; Jones, Power, Queenan, & Schulkin, 2015). Breastfeeding has been shown to attenuate obesity among Hispanic children in California (Whaley, Ritchie, Spector, & Gomez, 2012). This study will expand the current literature by comparing feeding practices of infants and children served by WIC in Indiana and their subsequent risk of obesity during the time of enrollment in WIC and will provide a deeper understanding of the role of breastfeeding in the prevalence of obesity, especially among Hispanic WIC participants in Indiana.

Assumptions

The researcher makes the following assumptions in the implementation of the study and in the interpretation of the data:

1. The measurements were conducted and recorded accurately.
2. All appropriate outliers were removed from the data set prior to analysis.
3. The data accurately reflect feeding practices among infants and children younger than 5 years old.
4. The Hispanic children served by WIC in Indiana are representative of Hispanic children in the United States, allowing the results to be generalized.

Definitions

For the purpose of this study, the following definitions will be used:

1. **Childhood obesity:** A Body Mass Index (BMI) at the 95th percentile or greater for children and teens of the same age and sex (Barlow & Expert Committee, 2007).

2. **Childhood overweight:** A Body Mass Index (BMI) at or above the 85th percentile and below the 95th percentile for children and teens of the same age and sex (Barlow & Expert Committee, 2007).
3. **Complementary feeding:** Foods other than breast milk or infant formula (e.g. liquids, semisolids, and solids) introduced to an infant to provide nutrients (Infant Nutrition Guide, 2009).
4. **Exclusive breastfeeding:** Feeding an infant only breastmilk and no other food or water (Kleinman, 2014).
5. **Mixed feeding:** Breastfeeding plus formula feeding simultaneously (Zhou, Emerson, Husaini, & Hull, 2014).
6. **Sugar-sweetened beverage (SSB):** Sodas (e.g. Coke and Mountain Dew) or other sweetened drinks (e.g. Gatorade, Red Bulls, or Sunny Delight) (Davis, Whaley, & Goran, 2012).
7. **WIC:** The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). The mission of this federal program is to safeguard the health of low-income women, infants, and children up to age 5 years who are at risk for poor nutrition by providing nutritious foods to supplement diets, nutrition education, and referrals to health care and other social services (Schultz, Byker Shanks, & Houghtaling, 2015).

Summary

Childhood obesity is a current public health concern, with Hispanic children having the highest prevalence rates of childhood obesity in the United States. Current literature links feeding practices as a modifiable and preventable factor of childhood obesity. Programs such as

the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) provide supplemental foods, nutrition education, and breastfeeding counseling to low-income pregnant women, infants, and children up to their fifth birthday. Infants and children served by WIC, particularly Hispanic children, have a high prevalence of obesity. By examining the relationship between infant feeding practices and subsequent obesity during the first five years of life, this study will contribute to the limited knowledge regarding feeding practices and childhood obesity. This study aims to develop a better understanding of the impact of feeding practices among WIC participants and the prevalence of childhood obesity among this population. The results of this study could provide additional evidence regarding the role of breastfeeding in reducing the prevalence of childhood obesity served by WIC, especially among Hispanics.

CHAPTER 2

REVIEW OF LITERATURE

The purpose of this study was to determine the relationship between infant feeding practices and the subsequent classification of obesity among Hispanic and non-Hispanic children 2- to 5-years of age served by the WIC program in Indiana between 2008 and 2012. This chapter provides a review of the literature that: 1) describes and compares recommended infant feeding practices with current cultural practices, with an emphasis on the cultural practices of Hispanics; 2) describes factors influencing childhood obesity and the prevalence of childhood obesity, particularly among Hispanics; 3) provides an overview of the WIC program and the prevalence of childhood obesity among WIC recipients; and 4) reviews research that examines the relationship between obesity during childhood and infant feeding practices (i.e., full breastfed, partially breastfed, and formula fed) among WIC participants.

Infant Feeding Practices

Studies have shown the potential link between infant feeding practices in the first two years of life and subsequent health status in both childhood (Whaley et al., 2014) and adulthood (Muniandy, Allotey, Soyiri, & Reidpath, 2016), with early infant nutrition playing a primary role in the health of a person throughout their life (Heinig et al., 2006). Health outcomes differ significantly by type of infant feeding practice implemented (Stuebe & Schwarz, 2010). Thus,

infant feeding practices, especially, breastfeeding, formula feeding, and mixed feeding with both breast milk and infant formula, are of particular interest due to their potential role in influencing body composition, overweight, and obesity later in life (Gale, Logan, Santhakumaran, Parkinson, Hyde, & Modi, 2012; Appleton, Laws, Russell, Fowler, Campbell, & Denney-Wilson, 2018).

The first years of a child's life are an important period for introducing and establishing healthy eating habits such as encouraging the consumption of a variety of nutrient dense foods (Hamner, Perrine, Gupta, Herrick, & Cogswell, 2017). Currently, the American Academy of Pediatrics (AAP) recommends exclusive breastfeeding for the first 4 to 6 months of life, the introduction of solid foods at 4 to 6 months of age, continued breastfeeding to the first birthday and beyond, if possible, and the use of infant formula for the first year of life for those infants who are not breastfed (Kleinman, 2014).

Epidemiology

Five terms are used to describe the extent to which infants are breastfed: (1) Ever breastfed, (2) Breastfeeding at 6 months, (3) Breastfeeding at 12 months, (4) Exclusive breastfeeding at 3 months and (5) Exclusive breastfeeding at 6 months (Centers for Disease Control and Prevention [CDC], 2017). These terms are used to define the breastfeeding goals outlined in *Healthy People 2020* (ODPHP, 2017). According to the *2018 Breastfeeding Report Card* (CDC, 2018a), of all infants born in the United States in 2015, 83.2% of infants were classified as "ever breastfed," meeting the *Healthy People 2020* goal of 81.9%. At 6 months of age, however, only 57.6% of infants were still being breastfed, below the national goal of 60.6%. At one year of age, slightly more than one-third (35.9%) of infants were still breastfed, meeting the national goal of 34.1%. An estimated 46.9% of infants were exclusively breastfed through three months, meeting the national goal of 46.2%. Lastly, 24.9% of infants were exclusively

breastfed through 6 months, below the national goal of 25.5% (CDC, 2018a). According to CDC National Immunization Survey data, among U.S. children born between 2009 and 2015, the prevalence of breastfeeding (i.e., "ever breastfed) in the United States varied by race and ethnicity, with rates highest among non-Hispanic Asians (89.3%), non-Hispanic white infants (85.9%), and Hispanics (84.6%) and lowest among non-Hispanic black infants (69.4%) (CDC, 2018b).

Breastfeeding

Breast milk, the optimal food for infants, and breastfeeding have been found to be beneficial for both mother and infant (Jacobson et al., 2015), particularly for minority women (Jones et al., 2015).Breastfeeding is seen as a healthy behavior that transcends not only national boundaries but also, due to its cultural and discipline differences, is of high interest internationally (Vari, Vogeltanz-Holm, Olsen, Anderson, Holm, Peterson, & Henly, 2013)

Exclusive breastfeeding is defined as feeding an infant only breastmilk and no other type of food or water (Mathur & Dhingra, 2013). The benefits of breastfeeding are most apparent when an infant is exclusively breastfed (Jenkins, & Foster, 2014). In 2012, worldwide, approximately 38% of infants under 6 months of age were exclusively breastfed (Yan, Liu, Zhu, Huang, & Wang, 2014).

Physical and psychological benefits of breastfeeding

Breastfeeding, and particularly breast milk, has been described as important for the optimal long-term health of both the mother and infant (Syme, Holt, Fell, & Crawley, 2015). Early initiation of breastfeeding and exclusive breastfeeding in the first month of life can have a positive impact on mortality (Mathur & Dhingra, 2013; Khan, Vesel, Bahl, & Martines, 2015).

Breastfeeding is one of the most effective interventions to prevent mortality in children under the age of five (Holla-Bhar, Iellamo, Gupta, Smith, & Dadhich, 2015).

Breastfeeding is physiologically natural, economical, and convenient (Mathur & Dhingra, 2013). Breastmilk is considered the ideal food to meet the infant's needs due to the nutrient and energy content it provides (Yan et al, 2014). Breastmilk is rich in essential fatty acids, lactose, long-chain polyunsaturated fats (LCPUFA), and phospholipids, and provides enzymes that increase digestibility and defend against microbes (Mathu & Dhingra, 2013). Studies have shown a positive association between LCPUFA and health outcomes, including the promotion of brain growth and a reduced risk of dyslexia and hyperactivity (Mathur & Dhingra, 2013).

Breastfeeding transfers maternal antibodies and T-lymphocytes to the infant, providing protection against certain infectious diseases (Mathur & Dhingra, 2013). Infants who were exclusively breastfed have been shown to have higher intelligence quotient, better mathematical skills, and a reduced risk for infections, asthma, and other allergic disorders (Mathur & Dhingra, 2013). Children who are breastfed for longer periods of time have lower infectious morbidity and mortality, fewer dental malocclusions, and higher intelligence than those who are not breastfed at all or who were breastfed for shorter periods of time (Victora et al., 2016).

Yan et al. (2014) found that breastfeeding has a protective effect for childhood obesity, with prolonged breastfeeding (i.e., 7 months or longer) directly associated with a decreased risk for obesity later in childhood. Wang, Collins, Ratliff, Xie, & Wang (2017) stated that the association between breastfeeding and childhood obesity can be explained by breastfeeding's biological mechanisms, as breast milk contains fewer calories and nutrients such as sugar, water, protein, and fat, and includes bioactive substances such as leptin and ghrelin.

Some benefits for breastfeeding mothers include a decreased risk of breast, uterine and ovarian cancer; reduced postpartum bleeding; promotion of early uterine involution; improved birth spacing; reduced risk of diabetes; and promotion of postpartum weight loss (Mathur & Dhingra, 2013; Victora et al., 2016). Psychologically, breastfeeding has been shown to be beneficial for both mother and infants as it increases the emotional value of the bonding process between the mother-infant dyad (Vari et al., 2013).

Epidemiological studies comparing breastfed infants to non-breastfed infants

Howel and Ball (2013) examined factors associated with the cessation of breastfeeding in the North-East Cot trial (NECOT) of mothers. These researchers defined breastfeeding outcomes three ways: 1) exclusively breastfeeding from birth, 2) any breastfeeding from birth, and 3) cessation of any breastfeeding after starting complementary feeding. Overall, 94% of participants initiated breastfeeding and 47% were still breastfeeding at 6 months; 66% initiated exclusive breastfeeding; and <1% were still exclusively breastfeeding at 6 months. These researchers noted that longer exclusive breastfeeding was associated with an overall longer breastfeeding duration once supplementation was initiated.

Khan, Vesel, Bahl, and Martines (2015) conducted a systematic review to examine the effect of initiation of breastfeeding early after birth, and of exclusive breastfeeding during the first month on neonatal mortality and morbidity rates. After searching the Cochrane and PubMed databases, the authors identified eleven papers that addressed the review questions. Results of this meta-analysis indicated that early initiation of breastfeeding was associated with a reduced risk of neonatal mortality. Initiating breastfeeding after the first hour doubled the risk of neonatal mortality. Exclusively breastfed neonates had a lower risk of mortality and infection-related deaths in the first month than partially breastfed neonates. In addition, exclusively breastfed

neonates had a significantly lower risk of sepsis, diarrhea and respiratory infections compared with those partially breastfed. The pooled evidence indicated that substantial benefits in reducing neonatal mortality and morbidity can be achieved with effective promotion of early initiation of breastfeeding and exclusive breastfeeding during the first month of life.

Health outcomes of breastfeeding

Breastfeeding has been linked to many positive health outcomes in children, including a lower risk of acute ear infections, respiratory tract infections, asthma, obesity, diabetes mellitus, and leukemia (Park, Kim, Kim, Shin, Yoo, & Cho, 2014). Jenkins, & Foster (2014) noted an association between breastfeeding duration and exclusivity with cognitive, behavioral, and achievement outcomes during childhood. Positive behavioral outcomes include a greater degree of engagement and emotional regulation, fewer abnormal reflexes, signs of depression and withdrawal, and more alertness during social interactions.

The positive health effects associated with breastfeeding are typically measured based on duration, exclusivity, or volume of breast milk consumed by infants (Jenkins, & Foster, 2014). The methodologies used to measure these variables have been described as challenging, however, due to several cofounding and unmeasured variables (Jenkins, & Foster, 2014). In a policy statement, the American Academy of Pediatrics (AAP) (2012) argued that methodologic issues exist regarding breastfeeding and infant and maternal health outcomes. Consequently, most published reports include observational cohort studies and systematic reviews/meta-analysis, making cause-effect relationships difficult to pin-point.

Park el al. (2014) examined the association between breastfeeding and attention-deficit hyperactivity disorder (ADHD), behavioral problems in childhood, and the intelligence quotient (IQ) of mothers and their children. Subjects included 874 children aged 8-11 years and their

mothers who were recruited from five schools in Korean cities. The mothers were asked about the feeding method (i.e., breastfeeding, bottle-fed, or mixed) in infancy and the prevalence of ADHD and behavioral problems. Participants were divided accordingly to infant feeding practice reported (i.e., breastfed vs. non-breastfed). Results indicated an increase in behavioral problems and a higher diagnosis of ADHD in the non-breastfed group. In contrast, the intelligence quotient (IQ) of both the mothers and the children were significantly higher in the breastfed group (maternal IQ: $p=0.036$; child's IQ: $p<0.001$).

Victora et al. (2016) completed a systemic review and meta-analysis in which the researchers examined the short- and long-term health consequences of breastfeeding. The analysis indicated the decision not to initiate breastfeedin has major long-term effects on the health, nutrition and development of the child and on the health of the mothers.

Wang et al. (2017) examined the effects of breastfeeding duration on the development of childhood obesity from 24 months through sixth grade. Data from a selected cohort of 1,234 children and their mothers were abstracted from the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development (SECCYD) for analysis. The study restricted the analysis to children with measured height and weight data in at least one of the six time points when follow-up surveys were given (i.e., when the child was 24 months, 36 months, or 54 months old and/or in grades 1, 3, or 6) and to those with information on their breastfeeding history one month after birth (n=1,234). Only information about breastfeeding at one and six months of age was used due to a large amount of missing data at other time points. Breastfeeding was dichotomized into two categories (i.e., breastfeeding and not breastfeeding). Data was analyzed using logistic regression models and generalized estimating equation (GEE). Logistic regression showed that breastfeeding at one month was

associated with a 53% (OR: 0.47, 95% CI: 0.30–0.73) and a 47% (OR: 0.53, 95% CI: 0.36–0.78) decreased risk for childhood obesity at grades 1 and 6, respectively. The GEE analysis showed that breastfeeding at one month reduced the risk for childhood obesity by 36% (95% CI: 0.47–0.88) from ages 24 months through grade 6. Breastfeeding for more than 6 months (vs. never) was associated with a 42% decreased risk for childhood obesity (OR: 0.58, 95% CI: 0.36–0.94).

The American Academy of Pediatrics (2012) summarized findings from a report prepared by the Evidence-based Practice Centers of the Agency for Healthcare Research and Quality (AHRQ) of the U.S. Department of Health Human Services that provided an expanded analysis regarding health outcomes of the dose-response relationship between the duration of breastfeeding and protective effect. The following findings were described:

1) Any breastfeeding is associated with a 64% reduction in the incidence of nonspecific gastrointestinal tract infections;
2) Any breastfeeding is associated with 36% reduced risk of sudden infant death syndrome (SIDS);
3) Exclusive breastfeeding for at least three months is associated with up to a 30% reduction in the incidence of type 1 diabetes mellitus, and a reduction of 40% in the incidence of type 2 diabetes mellitus;
4) Exclusive breastfeeding for 3 to 4 months reduced the incidence of clinical asthma, atopic dermatitis, and eczema by 27% in a low-risk population and up to 42% in infants with positive family history;
5) Exclusive breastfeeding for more than four months is associated with a 72% reduction in hospitalizations for lower respiratory tract infections in the first year;

6) Breastfeeding for six months or more is associated with a20% reduction in the risk of acute lymphocytic leukemia and a 15% reduction in the risk of acute myeloid leukemia in infants.

7) Breastfeeding at the time of gluten exposure is associated with a 52% reduction in celiac disease in infants. Overall, a positive association between increased breastfeeding duration and reduced risk of celiac disease when measured as the presence of celiac antibodies; and

8) Breastfeeding is associated with 31% reduction the risk of childhood inflammatory bowel disease;

Factors associated with breastfeeding prevalence and duration

Breastfeeding is a human behavior sensitive to cultural influence (Larsen & Kronborg, 2013).In addition to culture, breastfeeding prevalence and duration can be influenced by several other factors, including socio-economic factors, religion, education, support services (Mathur & Dhingra, 2013), maternal race/ethnicity, employment, inadequate knowledge regarding breastfeeding, lack of familial and societal support, and lack of guidance and encouragement from health care professionals (Yan et al., 2014). According to Cisco (2017), women who lack support for breastfeeding are least likely to initiate breastfeeding and are most often young women of minority status with low socioeconomic status.

Many factors have been linked to a decreased adherence to breastfeeding recommendations, including the perceived breast milk insufficiency, sore nipples, breast engorgement, mastitis and breast abscess, and inverted/flat nipples (Mathur & Dhingra, 2013). Medical conditions in which breastfeeding is contraindicated include when an infant has a metabolic disorder (i.e., galactosemia, and phenylketonuria), for women who are positive for

human T-cell lymphotrophic virus type I or II, HIV-positive mother, and untreated brucellosis (AAP, 2012). Additional factors that may impact the ability of women to initiate or continue breastfeeding include employment policies, state and federal laws regarding breastfeeding in public, and access to healthcare professionals (Cisco, 2017).

Actions that support breastfeeding

Breastfeeding has been described as one of the most cost-effective interventions to prevent mortality in children under the age of five (Howel & Ball, 2013). Three main facilitators that empower women to breastfeeding include: 1) health system factors, 2) individual and family factors, and 3) social and cultural factors (Kohan, Heidari & Keshvari, 2016). Health professionals are encouraged to do all they can to promote breastfeeding practices (Mathur & Dhingra, 2013).

The World Health Organization (WHO) has developed several breastfeeding initiatives, including the Baby Friendly Hospital Initiative (BFHI), which recommend practices to support breastfeeding and increase the likelihood of optimum breastfeeding among lactating women (Mathur & Dhingra, 2013). The BFHI is a global program sponsored by the WHO and the United Nations Children's Fund (UNICEF) to encourage and recognize hospitals and birth centers that offer an optimal level of care for breastfeeding (CDC, 2017).

In 2018, UNICEF and the World Health Organization (WHO) published a revision of *Ten Steps to Successful Breastfeedin*g, a list of policies and procedures that facilities providing maternity and newborn services were encouraged to implement to support breastfeeding (WHO, 2018). The WHO called upon all facilities providing maternity and newborn services worldwide to implement the *Ten Steps*. The revised guidance focuses on integrating the program more fully into the health care system to ensure all facilities in a county implement the Ten Steps (WHO,

2018). The revised steps are subdivided into the following Critical Management Procedures and Key Clinical Practices:

Critical Management Procedures

1a. Comply fully with the International Code of Marketing of Breast-milk Substitutes and relevant World Health Assembly resolutions.

1b. Have a written infant feeding policy that is routinely communicated to staff and parents.

1c. Establish ongoing monitoring and data-management systems.

2. Ensure that staff have sufficient knowledge, competence and skills to support breastfeeding.

Key Clinical Practices

3. Discuss the importance and management of breastfeeding with pregnant women and their families.

4. Facilitate immediate and uninterrupted skin-to-skin contact and support mothers to initiate breastfeeding as soon as possible after birth.

5. Support mothers to initiate and maintain breastfeeding and manage common difficulties.

6. Do not provide breastfed newborns any food or fluids other than breast milk, unless medically indicated.

7. Enable mothers and their infants to remain together and to practice rooming-in (i.e., the infant and mother are in the same room) 24 hours a day.

8. Support mothers to recognize and respond to their infants' cues for feeding.

9. Counsel mothers on the use and risks of feeding bottles, teats and pacifiers.

10. Coordinate discharge so that parents and their infants have timely access to ongoing support and care.

Breastfeeding is a priority for the WIC program. Panzera, Castellanos-Brown, Paolicelli, Morgan, Potter, and Berman (2017) explored national studies to highlight findings on important benefits of WIC; changes in attitudes toward, beliefs about, and intentions to breastfeed; and breastfeeding initiation and duration rates among mothers enrolled in WIC. The WIC food packages are designed to incentivize mothers to breastfeed by providing greater quantity and variety of healthy foods. The WIC IFTFPS-Infant Year Report found that choosing to breastfeed was influenced by the benefits of a fully breastfeeding food package, as 61% of breastfeeding mothers indicated they were aware of the fully breastfeeding food package at three months post-partum. Another initiative that promotes and supports breastfeeding among WIC participants is the availability of trained WIC staff and breastfeeding peer counselors (Panzera et al., 2017). A recent WIC breastfeeding report (USDA, 2017) indicated the number of WIC infants reported as breastfed increased slightly from 30.9% in 2015 to 31.7% in 2016. This increase was attributed to the efforts of WIC to provide and promote quality breastfeeding services.

Mathur and Dhingra (2013) suggested preparing mothers for breastfeeding in the antenatal period can have a positive impact on mother's intention to breastfeed her infant. These authors suggested this can be achieved by sensitizing the mother toward the importance of breastfeeding, assessing the mother's intention to breastfeeding, and identifying factors that may influence success of breastfeeding, such as informing the advantages of early initiation of breastfeeding and involving partners during the antenatal visits.

Clinical examination and observation of any nursing mother during a breastfeeding session may help health professionals to identify if any breastfeeding problems exist. To

encourage breastfeeding, it is important to follow good counseling skills such as implementing positive nonverbal communication, asking open ended questions, and avoiding using judging words (Mathur & Dhingra, 2013).

Formula Feeding

The *Infant Nutrition and Feeding Guide* (USDA, 2009) defined infant formula as a food which purports to be or is represented for special dietary use solely as a complete or partial substitute for human milk. The Infant Feeding Practices Study II (IFPS II), a longitudinal study that followed approximately 2000 mother-infant pairs from the third trimester of pregnancy throughout the first year of life, was conducted by the Food and Drug Administration (FDA) and the CDC in 2005-2007. The IFPS II found that the majority of infants (59.3%) were formula fed after birth, with the percentage of formula-fed infants increasing to 67.5% by 6 months of age (CDC, 2017).

Most of the infant-feeding research focuses on identifying mother's reasons for the cessation of breastfeeding; as a result, the experiences of mothers who choose to use formula is largely overlooked in quantitative designs (Fallon et al., 2016). In many instances, information about formula fed infants is only found in studies that primarily focused on factors associated with breastfeeding and cessation of breastfeeding, rather than on factors associated with the choice to formula feed.

Although breastfeeding is the recommended method of infant feeding internationally (Smith et al., 2016), exclusive breastfeeding for the first 6 months of life remains low in several countries, particularly in low income settings where infants are more susceptible to malnutrition and childhood infections (Nor, Ahlberg, Doherty, Zembe, Jackson & Ekstrom, 2012). In many

developed countries, achieving the breastfeeding recommendation remains a challenge (Fallon et al., 2017). In addition, the concept of "exclusive" feeding has been shown to be misinterpreted as meaning "not mixing two milks" by mothers (Nor et al., 2012).

Many reasons have been given for choosing formula feeding over breastfeeding. Appleton et al. (2018) noted that the decision to formula-feed is affected by several factors, including the infant's cues of hunger and satiety; other external cues, such as the amount of milk in the bottle; and external sources of advice. In addition, some women are physically unable to breastfeed due to biological problems, such as hypoplasia, breast abnormalities, prior surgery, or other medical contraindications (Fallon, Komninou, Bennett, Halford, & Harrold, 2017). If a woman is unable to, or chooses not to, breastfeed, the BFI recommends infants be fed a standard whey-based infant formula for the first 12 months of life, unless otherwise indicated by a healthcare professional (Smith et al., 2016).

The increased availability and promotion of formula feeding may impact and reduce mother's confidence to exclusively breastfeeding (Nor et al., 2012). It is well known that formula companies produce and distribute free and visually appealing education materials, which may tempt women to consider choosing formula (Chezem, Friesen, & Clark, 2001). In addition, one factor that may contribute to low breastfeeding rates among WIC participants is the food package that provides free infant formula (Chezem, Friesen, & Parker, 2004).

According to Fallon et al. (2017), women who initiate breastfeeding and then transition to formula feeding tend to be susceptible to have increased feelings of distress. In addition, conflicts handling formula may arise among new parents. Fallon et al. (2017) noted that inadequate or excessive intake of calories and nutrients, dehydration, and diarrhea may result as consequence of inadequate conditions when handling formula milk. Walsh, Kearney & Dennis

(2015) argued that society's perception of a healthy baby is not consistent with a normal weight range, due to high rates of artificially fed infants.

In a systematic review, Appleton, Russell, Laws, Fowler, Campbell & Denney-Wilson (2018) explored supporting evidence for a range of formula feeding practices associated with rapid weight gain (RWG) in infancy. These researchers examined formula feeding practices that may increase the risk of formula fed infants experiencing RWG based on the three pathways of nutrient profile, mode of delivery, and parents' feeding practices. At present, there is limited evidence that identifies formula feeding practices as being associated with RWG in infancy. Further studies are needed before firm recommendations can be made.

According to Smith et al. (2016), parents are often not aware of the differences between the type and brand of infant formula in the market. de Lauzon-Guillain et al. (2018) used data from the French national birth cohort Etude Longitudinale Française depuis Enfance (ELFE study) to describe the type of infant formula used during the first year of life and to examine whether the selection of different types of infant formula varied according to family characteristics, physician, or the parental report of infant's health-related factors. The analysis included 10,293 formula fed infants at 2 months of age. Results indicated that at 2 months of age, 58.1% of formula-fed infants received formula enriched in prebiotics or probiotics, 31.5% with thickened formula, and 1.4% with extensively hydrolyzed formula. Infants with a family history of allergies and parental concerns related to digestive symptoms were fed with extensively and partially hydrolyzed formula. Overall, researchers argued that the use of different types of infant formula was stable between 2 and 10 months, and the selection of different types of infant formula was mostly related to infant's health-related factors and a family history of allergies.

Infant feeding practices often become a “moral minefield” and an “accountable matter” for mothers, with emotions such as guilt and blame frequently reported by non-breastfeeding mothers (Thomson, Ebisch-Burton & Flacking, 2015). Nor et al. (2012) explored mother’s perceptions and experiences of infant feeding within a community-based peer counseling intervention in South Africa that promoted exclusive breast or formula feeding. The qualitative study included 17 mothers, in which seven women were HIV-positive, nine were HIV-negative and one had unknown HIV status. Researchers indicated that some factors promoting breastfeeding included the perception of a healthy baby and the prohibitive cost of formula. In contrast, factors promoting mixed feeding included concerns about the adequacy of the breast milk supply, the perceived need for water and traditional medicines, the mother’s limited understanding of exclusive infant feeding, and the stigma of not breastfeeding. A crying infant or an infant who did not sleep at night were cited as reasons for introducing semi-solid foods as early as 1 month.

Many cultures associate breastfeeding as a synonymous with “good mothering,” and, as result, when women decide not to breastfeed they may experience guilt, blame, and feelings of failure (Thomson et al., 2015). Fallon et al. (2017) studied 601 mothers and infants up to 26 weeks of age who were currently formula feeding in any quantity to examine the emotional and practical experiences of mothers who used formula. These researchers observed that a high percentage of mothers experienced negative emotions, including guilt (67%) about their choice of feeding method, stigma (68%), and the need to defend their decision to use formula (76%). Guilt was more likely to be internally motivated (30%) than from external sources (12%), with the majority of participants experiencing guilt from both sources. Most of the mothers reported low to moderate levels of infant feeding support (64%) by health professionals. In addition,

Fallon et al. (2017) assessed whether these experiences varied according to prenatal feeding intention and postnatal feeding type. Results indicated that mothers who had intentions to exclusively breastfeed in pregnancy (I-EBF), and those mothers who were exclusive breastfeeding (EBF) and subsequently were exclusive formula feeding (EFF), were significantly more likely to experience guilt about their choice of infant feeding method than other groups (RRR:0.14; 95% CI:0.08, 0.26 vs. RRR:0.25; 95% CI:0.15, 0.41). These findings support criticisms of how infant-feeding recommendations are framed by health care professionals and policy makers and highlight the need to address formula feeding in a more balanced, woman-centered manner.

The feeling of "shame" incorporates affect (e.g., fear, anger, humiliation, self-disgust, anxiety, low self-esteem, and depression), cognitions (e.g., feelings of rejection, inferiority, and inadequacy), and actions (e.g., withdrawal and isolation or retaliation) (Thomson et al., 2015). Thomson et al. (2015) explored the perspective of infant feeding by describing how shame is evident within the experiences of breastfeeding and non-breastfeeding women. The researchers described how shame was experienced by both breastfeeding and non-breastfeeding women (i.e., women disclosed affective responses of shame, such as feelings of fear, humiliation, inferiority, and inadequacy), and these women are susceptible to experience inadequate support, judgement and condemnation, which may lead to feelings of failure, inadequacy and isolation.

In a systematic review and meta-analysis, Gale et al. (2012) analyzed studies that reported outcomes of healthy full-term (37-42 weeks of gestation) infants (0-12 months of age). Researchers analyzed fat mass (Kg), fat-free mass (Kg), and the percentage of fat mass, and identified discrepancies in growth patterns between breastfed and formula-fed infants. As observed by 12 months of age, those infants who were formula-fed weighed on average 400-600

g more than those who were breastfed. The formula-fed infants had higher fat-free mass throughout the first year of life (Gale et al., 2012).

In sum, infant feeding practices can be influenced by a variety of factors. The literature describes how the choice to formula feed is influenced by infant's cues of hunger and satiety and other external sources. In addition, infant feeding practice is associated with women's emotions and perceptions of motherhood.

Complementary Food

Complementary feeding is defined as the process of initiating solid foods and liquids other than breast milk or infant formula when these foods, on their own, are no longer sufficient to meet the nutritional needs of infants (Muniandy et al., 2016).Finding the ideal time to introduce complementary foods other than breast milk to an infant's diet is controversial and subject to continuing debate (Brodribb, & Miller, 2013).The World Health Organization (WHO) (2017) recommends that infants start receiving complementary foods at 6 months of age, supplemented with breastmilk.

Complementary foods introduced too early may lead to poor nutrition outcomes (i.e., low iron stores), and may lead to an increased risk of chronic disease, such as islet autoimmunity, obesity, adult-onset celiac disease, and eczema. Introducing solid foods too late is also not optimal because it may result in deficiencies of zinc, protein, iron, and vitamins B and D which, in turn, can suppress growth and cause feeding difficulties (Kuo et al., 2011).

Parents must understand the complementary feeding recommendations appropriate to the developmental stage of the infant. Advice related to introduction to solid foods given by pediatric clinicians can influence when parents introduce solid foods, because there are multiple opportunities of contact with the parents during an infant's first months of life (Kuo, Inkelas,

Slusser, Maidenberg, & Halfon, 2011). The American Academy of Pediatrics recommends that solid foods be introduced to healthy children no earlier than 4 to 6 months of age, as prior to this time infants are not developmentally ready to process solid foods for swallowing due to the extrusion reflex and neuromotor immaturity (Crocetti, Dudas, & Krugman, 2004).

Recommendations about when to begin, and the gradual completion of introduction of complementary foods, are the result of a balanced number of factors that allow infants to nourish themselves in an increasingly autonomous and complete way (Alvisi et al., 2015). A variety of foods should be introduced in amounts, frequency and consistency required to meet an infant's nutritional needs (Muniandy et al., 2016). The timely introduction of complementary foods has been shown to be assocated with the acquisition of milestones in neuromotor development, the development of taste and personal choices, the maturation of renal and gastrointestinal functionality, the qualitative and quantitative nutrient intake, and the interaction of cultural and socioeconomic factors with local and family traditions (Alvisi et al., 2015). In addition, timing of the introduction of complementary foods is associated with familial factors, including maternal ethnicity, cultural beliefs, education, breastfeeding status and duration, participation in the Supplementary Nutrition Program for Women, Infants, and Children (WIC), and whether a provider discussion of the introduction of solid foods had occurred (Kuo et al., 2011).

According to the World Health Organization (Department of Nutrition for Health and Development, 2000), common feeding recommendations include the following:

- up to 4 months of age, infants should be breastfed as often as the child wants day and night, with a minimum of 8 feedings in 24 hours;

- between 4 and up to 6 months of age, complementary foods could be introduced 1 or 2 times per day after breastfeeding, if the infant appears hungry after breastfeeding or if infant is not gaining weight adequately;
- between 6 month and up to 12 months of age, breastfeeding should be continued as often as the child wants, with the breastfed child being given 3 meals per day and the non-breastfed child given 5 meals per day, with nutritious snacks incorporated between meals;
- between 12 months and up to 2 years of age, breastfeeding should be continued as often as the child wants, with the child given 3 meals per day and 2 nutritious snacks; and
- children 2 years of age and older should eat family foods at 3 meals each day with 2 nutritious snacks between meals.

Baby-Led Weaning (BLW) is a method for introducing complementary foods in which the infants feed themselves with hand-held foods instead of being spoon-feed by parents (Alvisi et al., 2015). The BLW method is not recommended before 6 months of age as most infants are not developmentally able to achieve postural stability to sit and grasp objects until then. This method aligns with current recommendation that suggest complementary foods should not be introduce before 4 months of age and not later than 6 months of age.

Lindsay et al. (2017) explored the beliefs and infant-feeding practices of 29 Brazilian immigrant mothers in the United States. The majority of participants reported introducing their infants to solid foods at around 4 months of age due to infant hunger and cues of lack of satiety. The most commonly first food reported to be introduced was porridge made with infant cereals, with rice and maize being the two most commonly used components.

The *Infant Nutrition and Feeding: A Guide for Use in the WIC and CSF Programs* (USDA, 2009) recommends iron-fortified cereals as an appropriate first complementary food for infants, because of their easy digestion and significant contribution of iron and zinc to the diet. Wheat infant cereals should be introduced after 8 months of age in order to prevent a hypersensitivity reaction.

Attitudes, beliefs, and practices regarding complementary foods

A vast array of factors influences when a mother determines it is appropriate to introduce complementary feedings to their infant. Research has shown that factors such as personal attitudes and beliefs, as well as family and culture, have a relevant role in the timing of introduction to complementary feeding (Kuo et al., 2011; Lindsay et al., 2017).While it is known that complementary feeding practices differ among ethnic groups (Ahluwalia, D'Angelo, Morrow, & McDonald, 2012), there is limited research on the attitudes, beliefs, and practices regarding complementary feeding among Hispanics.

Children who were breastfed have been reported to be more likely to have healthier eating behaviors during their childhood (Hamner et al., 2017). Lindsay et al. (2017) concluded that most mothers do not exclusively breastfeed for the first 6 months of life. Early introduction to complementary foods and a decreased of breastfeeding duration are practices associated with an increased risk of unhealthy weight status and obesity in early childhood. Thus, family and culture emerged as important influences on mothers' infant-feeding beliefs and practices (Lindsay et al., 2017).

Hamner et al. (2017) used the 24-hour dietary recall from the National Health and Nutrition Examination Survey 2009-2014 to examine food consumption patterns among children≤ 23 months of age in the United States by race and ethnicity. A total of 1824 children

were included in the analysis. Of these, 27.5% were Hispanic, 13.2% were non-Hispanic black, and 50.7% were non-Hispanic white. Results indicated that food consumption patterns varied widely by age and race or ethnicity. Overall, on any given day, 42.9% of children birth to 5 months of age consumed breast milk, 70.5% consumed formula, 11.4% water, 2.1% 100% juice, 1.7% sugar-sweetened beverages, 8.2% fruit, 8.1% vegetables, 0.8% protein, and 21.1% grains. About four in ten children from 0 to 5 months old consumed breast milk 42.9% (95% CI: 37.0–49.1) but a lower percentage of non-Hispanic black children 21.2% (95% CI: 13.2–32.2) from 0 to 5 months old consumed breast milk compared with non-Hispanic white 49.0% (95% CI: 39.0–59.1) and Hispanic children 41.9% (95% CI: 32.1–52.3) on any given day. The researchers postulated that several factors, including food availability, parental diet, familial eating habits, and access to healthy food options, differed between races and ethnic groups.

Adherence, and barriers to complementary feeding recommendations

O'Donovan et al. (2015) described adherence with infant feeding and complementary feeding guidelines of 823 infants for whom a diary was completed using data from the Cork BASELINE Birth Cohort Study. Participants who completed a food diary were older (31 years old vs 29 years old), more likely to have a partner (96% vs 91%), to have obtained a university education (59% vs 47%), and to be non- smokers (90% vs 82%) compared to those who did not complete a diary. Most respondents (79%) indicated complementary feeding was introduced between 17 and 26 weeks of age. Eighteen percent reported introducing solid foods before 17 weeks of age. Of the 18% who were introduced to solid foods before 17 weeks, 28 and 44% were given solids at 15 and 16 weeks, respectively. Only 3% introduced complementary food after 26 weeks. Mothers of infants who commenced complementary feeding prior to 17 weeks were younger (29.8 v.31.5 years; $p<0{\cdot}001$), less well educated (no university degree: 55% v.

38%; p<0·0001) and more likely to smoke (18% v. 8%; p=0·004).The first foods introduced were baby rice (69%), infant breakfast cereals (14%), or fruit/vegetables (14%). The main reasons cited for starting complementary feeding included hungry infants (43%), recommendation of others (26%) [i.e., public health nurse (52%), doctor (21%), family member (19%), friend (9%)], and following specific complementary feeding guidelines (17%).

Multiple factors, including lack of knowledge about breastfeeding, unsupportive cultural and social norms, poor family and social support, and unsupportive work and childcare environments, keep mother from achieving their breastfeeding goals (Anstey, Chen, Elam-Evans, & Perrine, 2017). Exclusively breastfed infants tend to be introduced to water, formula, and sweetened beverages, specifically juice, later than non-exclusively breastfed or never breastfed infants (Sinigaglia et al., 2016). Heinig et al. (2006) indicated that a majority of mothers shared the belief that breastfeeding was healthier for the baby and would result in better bonding with their infants. Contradictory to their beliefs, many participants introduced formula or solid foods because they believed their infants' behavior could be modified by additional feeding.

Language barriers and cultural beliefs have been described as common factors influencing adherence to complementary feeding guidelines, especially among Hispanics. Heinig et al. (2006) examined the relationship among maternal beliefs, feedings intentions, and infant-feeding behaviors among 65 women who were divided into English speaking (n=28) and Spanish speaking (n=37) participants. Results obtained from the focus groups indicated that, within the English-speaking group, the types and order of foods given did not follow any specific recommendations and cereal tended to be offered as the first solid food. In contrast, Spanish-speaking participants indicated they were more likely to follow their doctor's advice to introduce one single food and watch for any adverse response. Likewise, Spanish-speaking mothers

reported that they deviated from current complementary feeding recommendations due to infant's behaviors such as infant crying, spitting up and waking, or their own medical problems. These researchers also suggested that intrapersonal beliefs can impact time of introduction to solid foods, with early introduction to complementary feeding and formula feeding perceived as appropriate. All mothers in the study indicated they considered complementary feeding guidelines should be flexible in order to adapt and reflect individual infant's needs (Heinig et al., 2006).

In sum, initiation of complementary feeding has been shown to differ among races and ethnicities. Attitudes, beliefs and practices perceived among mothers have been described in several studies that associated breastfeeding duration to early introduction of complementary feeding. Moreover, adherence to complementary feeding guidelines has been shown to differ as a consequence of environmental factors that influence child feeding practices.

Cultural Food Norms for Infants

The cultural norms of a society have a powerful influence over health behavior decisions, including the decision to choose an infant feeding method (Vari et al., 2013). Understanding the complexity of infant feeding decisions, and the significance social and cultural forces play, is essential for society (Head, 2017).

The preservation of cultural norms is defined as the actions or decisions of professional assistance, support, or facilitation skills that help people of a particular culture to retain and/or preserve relevant values in order to maintain their well-being (Rangel da Silva, Araujo da Cruz, Macedo, Rodrigues da Silva & Gomes, 2013). The United States, as part of the western culture, is characterized by being more individualistic, with a focus on individual's choices, goals and

rights (Dornan, Sinclair, Kernohan, Stockdale, Khuwuthyakorn, & Suppasan, 2015). The Theory of Planned Behavior (TPB) proposes that an individual's intention to perform a behavior is the most important determinant of their action. The TPB underlies the antecedents of attitude, subjective norms and perceived behavioral control, corresponding beliefs which reflect an individual's intention and subsequent behavior (Walsh, Kearney & Dennis, 2015).

Environmental factors have been shown to influence infant feeding practices among society. Vari et al. (2013) explained the role of ecological view of explaining breastfeeding behaviors. Models from the Bronfenbrenner ecological model (1979), Ecological Reformulation of the Theory of Planned Behavior for Breastfeeding, and Bandura's social cognitive theory of behavior (1977), describe the belief that an individual's learning is influenced by his or her environment. Thus, individual and/or family choices in regard to infant feeding practices can be affected by community perceptions of breastfeeding, and that families make infant feeding decisions in accordance to their surroundings (Vari et al., 2013). Walsh et al. (2015) indicated that first-time parents are more likely to be influenced by others, and group norms may influence women's behavioral intention on feeding practices and breastfeeding continuation. Grandmothers also play an important role as caregivers in the family; in most cultures, grandmothers are respected and valued for their expertise and experience, particularly in caring for the newborn and for transmitting their cultural practices (Rangel da Silva et al., 2013).

The mother's perception of a community's attitude toward breast feeding is a factor influencing her decision to breastfeed (Vari et al., 2013). In a qualitative semi-structured telephone interviews of 28 mothers living in Queensland, Australia, Maher & Lowe (2015) explored the health-related priorities of women during pregnancy and early motherhood and the motivators underpinning these priorities. Results revealed that nutrition, especially diet-related

practices, and physical activity behaviors, were key health priorities for both women in pregnancy and the early years.

The United Nations Children's Fund (UNICEF) (2018) reported that, on an international level in 2017, only 45% of newborns were put to the breast within one hour of birth, and 40% of infants were exclusively breastfed at 0 to 5 months of age. Daglas & Antoniou (2012) indicated that the small percent of women who exclusively breastfeeding worldwide are influenced by biological factors as well as by the habits, standards and behaviors that predominant in each society. Sociocultural factors, similarly to biological or physiological processes, have been described as one of the main factors influencing breastfeeding rates around the world due to the disparities observed among social characteristics between different countries and between women in the same societies (Head, 2017).

Social influence among infant feeding practices can occur directly (e.g., through the form of advice provision) or indirectly (e.g., through the form of internalized social norms) (Ashida, Lynn, Williams, & Schafer, 2015). In addition, strong locally held norms regarding the appropriateness of formula feeding and what is considered best for infants may discourage breastfeeding for some women and, as consequence, the resistance to public health services on infant feeding practices (Head, 2017).It has been described that immigrant women acculturate to the host country and, consequently, they become more likely to follow infant feeding practices that are comparable with those in the host country (Schmied, Olley, Burns, Duff, Dennis, &Dahlen,2012).

Increased acculturation among Hispanics in the United States has been associated with changes in their breastfeeding behaviors (Hohl, Thompson, Escareño, & Duggan, 2016).For each year a migrant woman resides in the US, the odds of her breastfeeding at all declines by 4% and

the odds of her breastfeeding for at least six months decreases by 3% (Schmied el al., 2012). Hohl et al. (2016) described specific cultural factors and perceptions that may affect changes in infant feeding behaviors among Hispanics. Results included 20 interviews of Hispanic participants aged 25-48 years who resided in the Lower Yakima Valley, Washington. The majority of participants (n=16; 80%) indicated they practiced combination feeding, whereas only three women (15%) exclusively breastfed their children, and only one participant (5%) exclusively formula fed her child. Hohl et al. (2016) described three main thematic categories described by these Hispanic women that influenced their infant feeding decision: breast is best; Hispanic cultural and familial expectations to breastfeed; and adapting to life in the United States: cultural norms in conflict. Similarly, health services and breastfeeding support may not meet the needs of immigrant women as they are not always accessible or culturally appropriate (Schmied el al., 2012).

In a bibliographic review, Daglas and Antoniou (2012) aimed to review the cultural practices, views and ideas of various cultures and the way they determine how much a natural and biological process, such as breastfeeding, is accepted. These researchers observed that cultural practices and beliefs within a society, such as the symbolism of female breasts, financial and social conditions influencing breastfeeding, and the attitudes and ideas concerning the quality of mother's milk, may influenced which procedure is considered natural and, as a consequence, accepted by people.

Finally, formula feeding is promoted by industry due to socio-cultural factors changes including the lack of support and encouragement from family members, the role of women in the society and their place in the workplace and the family, as well as the standards related to genders that may influenced women decisions to use artificial feeding (Daglas & Antoniou,

2012). In a meta-ethnographic study, Schmied el al. (2012) reported that the decision to formula feed is influenced by views of family members living in the new country.

In sum, cultural norms of a society have a powerful influence over health behavior decisions, including the infant feeding method. Infant feeding practices have been shown to differ among cultures, and are influenced by environmental factors, and sociocultural factors.

Childhood Obesity

Childhood obesity is an unhealthy body condition caused by gaining more weight than recommended (Kheirollahpour & Shohaimi, 2014). Being overweight as a child is defined as attaining a Body Mass Index (BMI) at or above the 85th percentile and below the 95th percentile by age and sex; if a child's BMI is at or above the 95th percentile for age and gender, the child's weight falls within the obese category (Barlow SE and the Expert Committee, 2007).Between 2011 and 2014, the prevalence of children and adolescents aged 2-19 years with obesity was 17% or 12.7 million children and adolescents. Hispanic children (21.9%) were more susceptible to obesity than non-Hispanics blacks (19.5%) or non-Hispanic whites (14.7%) (Ogden, Carroll, Fryar, & Flegal, 2015).

Childhood obesity is an increasing public health concern, as a child's weight status is set by age five, potentially adversely affecting their health and wellbeing during their childhood and adulthood (Mazarello Paes, Ong, & Lakshman, 2015). Childhood obesity has been linked to immediate and long-term adverse health outcomes such as sleep apnea, hypertension, heart disease, stroke, early onset of type 2 diabetes mellitus, osteoarthritis and certain types of cancer, and leads to psychosocial problems like stigmatization and poor self-esteem (An, 2017).

Inappropriate timing of the introduction of complementary feeding and an inadequate quantity or quality of foods can lead to overnutrition or undernutrition in a child (Muniandy et al., 2016).

Factors influencing childhood obesity

Dietary intake is a major environmental factor in the etiology of childhood obesity, as dietary habits acquired in childhood are likely to persist into adolescence and adulthood (Clark, Goyder, Bissell, Blank, & Peters, 2007). The parent's socioeconomic status, parental feeding practices, and the amount of physical activity in which a child engages appear to be the most important factors that effect a child's weight status (Kheirollahpour & Shohaimi, 2014). In addition, the process of acculturation has been described to impact eating habits and lifestyle practices among ethnic groups (Wojcicki, et al., 2012). Mazarello Paes et al. (2015) described energy balance-related behaviors (EBRBs) such as consumption of energy dense, nutrient poor food, drinks (i.e., sugar-sweetened beverages), and sedentary behaviors, as the main cause of the increase in the number of children who have overweight and obesity.

Many factors can affect the diet of infants and toddlers. In their systematic review, Mazarello Paes et al. (2015) describe how unhealthy food preparation, feeding practices, early weaning and early introduction of complementary food, were the most common factors found to affect a child's diet. Early exposure to added sugar intake also plays a role in increased prevalence of childhood obesity as result of the additional energy provided by the sugar sweetened beverage (SSB) intake (Davis, Whaley, & Goran, 2012). Sugar consumption, especially sugar-sweetened beverages, is a key modifiable factor that contribute to obesity and related metabolic disorders (Davis et al., 2012).

Parental perceptions toward modifiable factors may also influence childhood obesity. Messages related to obesity during childhood have been found to be more effective if they

address the mothers' needs and desires (Davis, Cole, Reyes, McKenney-Shubert, & Peterson, 2015). Most mothers believe that natural and processed juices are not harmful to their child's health (Jimenez-Cruz, Bacardi-Gascon, Castillo-Ruiz, Mandujano-Trujillo, & Pichardo-Osuna, 2010).

Physical activity has been shown to be strongly related to the weight status of children (Kheirollahpour & Shohaimi, 2014). An (2017) examined the relationship between diet quality, physical activity and obesity among US children 6-17 years of age using data from the 2003-2006 National Health and Nutrition Examination Survey (NHANES). This researcher compared the weight and activity status of children who consumed a healthy diet and were physically active to those who consumed an unhealthy diet and were physically inactive. Results indicated the overall risk of being overweight or obese was 19.0% (95% CI: 11.3-26.7) and 15.8% (CI: 10.5-21.2), respectively. The risk of obesity was highest among those who consumed an unhealthy diet and reported being physically inactive (16.5% [CI: 7.6-25.5]). The risk was slightly lower (13.5% [CI: 5.7-21.3] among children who consumed a healthy diet but who were physically inactive. The risk of obesity was lowest (3.2% [CI: -3.4-9.9] among children who consumed a healthy diet and were physically active.

A mother's BMI has been shown to have a positive relationship with the BMI of their child, with mothers having higher BMIs significantly more likely to have heavier children (Kheirollahpour et al., 2014). In addition, obese mothers have been found to be more likely to underestimate their child's weight than normal-weight mothers (Jimenez-Cruz et al., 2010). Populations with high obesity prevalence had developed a common tendency to underestimate their weight status (Rendón-Macías, Rosas-Vargas, Villasís-Keever, & Pérez-García, 2014), potentially causing children to perceive distinct messages that might generate confusion

regarding overweight and obesity. In a cross-sectional study that included 379 students, 7-9 years old in the state of Selangor and Federal territory of Kuala Lumpur. Kheirollahpour et al. (2014) explored the relationship between the socioeconomic status, parental feeding practice, physical activity, and weight status of children. Socioeconomic was shown to be strongly related to feeding practices and weight status of children, with parents of higher socioeconomic status more knowledgeable about the benefits of physical activity and more likely to have easier access physical facilities (X^2 (12,379) = 13.7, p<0.05) (Kheirollahpour et al., 2014).

Rendón-Macías et al. (2014) surveyed 1335 randomly selected children aged 6-12 years from elementary schools in Mexico City in an effort to understand children's perceptions regarding obesity and quality of life. Variables examined included gender, age, nutritional status, and the child's perception of their parent's nutritional status. Results indicated that most children (64.7%) considered obesity as a negative condition that influences health and social performance, with this perception inversely related to age (OR = 0.6, 95% CI: 0.5–0.9; p = 0.003) and the perception of their mother nutritional status (OR = 0.5, 95% CI: 0.3–0.8; p = 0.01).

Jimenez-Cruz et al. (2010) aimed to assess the perceptions of low-income mothers living in Mexico regarding their child's weight status and physical activity, and their beliefs about healthy and high-density foods. A total of 813 mothers and their infants were included in the study. Infants ranged in age from 5 to 24 months. Anthropometric measurements and interviews were conducted at the clinic where the mothers were recruited. Overall, 43% of mothers underestimated their child's weight status. When the subjects were categorized by weight status of the child, 83% of the mothers of children who were overweight or obese underestimated their child's weight. Mothers were more likely to underestimate their child's weight when they were obese themselves (OR = 1.6, 95% CI: 1.1-2.4; p= 0.02), had an overweight or obese child (OR =

68.9, 95% CI: 39.5-120.3; p=0.0001), had a monthly income higher than $600 (OR = 2.6, 95% CI: 1.4-4.8; p=0.002), had less than 6 years of education (OR = 1.6, 95% CI: 1.1-4.8; p=0.03), and who migrated to their current state of residence (OR = 2.1, 95% CI: 1.4-3.0; p=0.0001). Overall, only 12% of the mothers indicated they wished their children were more active, with 11% (p=0.005) of the mothers indicating they wished their children were less active and 77% indicating they wanted their children's physical activity patterns to continue as they were. The researchers concluded that low-income Mexican mothers highly underestimate their infant's weight status and have higher risks of fostering an obesogenic environment.

Clark et al. (2007), in a review of recent literature regarding child feeding behaviors and child weight, found that parents report using a wide range of child-feeding behaviors, including monitoring, pressure to eat, and restriction. Of these behaviors, restriction of children's eating was most frequently and consistently associated with weight gain, with substantial evidence indicating a causal relationship between parental restriction and childhood overweight. The authors concluded that parents may inadvertently promote excess weight gain in childhood by using inappropriate child-feeding behaviors. The authors recommended that interventions to increase awareness of the possible consequences of inappropriate child-feeding behaviors be developed and that parents who are concerned about their child's weight should be given the guidance and support they need in order to adopt more appropriate child-feeding behaviors.

Liu, Hannon, Qi, Downs, & Marrero (2015) used an accelerated failure time (AFT) model to describe the emergence of overweight based on a 12-year collection of height and weight data of 43,842 children from the Regenstrief Medical Record System (RMRS). This study included children between 3 and 16 years of age from seven urban primary care clinics (Indiana University Medical Group) in Marion County, Indiana, between the years of 1993 and

2004. Researchers found that the percentage of overweight Hispanics children was higher (29.7%) than white (22.4%) and black (23.1%) children. Additionally, researchers found that regardless of sex or insurance status, Latino children become overweight at younger ages than children of other races/ethnicities.

In sum, the scientific literature that examines obesity during childhood includes both qualitative and quantitative studies that have analyzed a vast array of factors associated with obesity, including ethnicity. Overweight and obesity may be detrimental for a human being, especially for children who are more susceptible to develop adverse health outcomes throughout adolescence and adulthood. Diet, including SSB intake, and other modifiable factors, such as physical activity, contribute to childhood weight status. Moreover, obesity during childhood has a higher prevalence among Hispanics compared to other races. Research is needed to determine appropriate and efficient programs to promote nutrition education and physical activity among minorities groups, and to better understand the role of infant feeding practices, to reduce overweight and obesity among these groups.

Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)

The mission of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), a federal program administered by the Food and Nutrition Service of the United States Department of Agriculture, is to safeguard the health of low-income women, infants, and children up to age 5 years who are at risk for poor nutrition by providing nutritious foods to supplement the diet, nutrition education, and referrals to health care and other social services (Schultz, Byker Shanks, & Houghtaling, 2015). The WIC program, established as a pilot program in 1972, was made permanent in 1974 (Thorn et al., 2015). Legislative requirements for

the WIC program are contained in Public Law 111–296, known as the *Healthy, Hunger-Free Kids Act of 2010* (Federal Register, 2014).

To be eligible for the WIC program, an applicant's income must not exceed 185 percent of the Federal poverty guidelines (Bullinger & Gurley-Calvez, 2016; ASPE, 2018). Those who are eligible for the Special Supplemental Nutrition Assistance Program (SNAP), Medicaid, or Temporary Assistance for Needy Families, are automatically eligible for WIC (Bullinger & Gurley-Calvez, 2016). In addition, applicants must reside in the state where they apply, and they must be considered at nutritional risk by a health professional before they can be enrolled into the program (Thorn et al., 2015). There are four classes of WIC eligibility: categorical, residential, income, and nutrition risk (Thorn et al., 2015). Categorically, the WIC program serves pregnant women, postpartum women with a child under the age of six months, breastfeeding women with a child under 12 months, and infants and children under the age of five years (Bullinger & Gurley-Calvez, 2016).

The WIC program only provides participants specific nutrient-dense food items that are authorized to be included in the WIC food packages. A final rule revising the food packages, published on March 4, 2014, completed implementation of the first comprehensive revisions to the WIC food packages since 1980 (https://www.fns.usda.gov/wic/fr-030414).

The WIC food packages are divided into two categories: Children (ages 1-4) and Women (Federal Register, 2014). The food packages for Women are subdivided into three categories: 1) pregnant and partially breastfeeding (up to 1 year postpartum), 2) postpartum (up to 6 months postpartum, and 3) fully breastfeeding (up to 1-year post-partum) (Federal Register, 2014). All WIC participants use their WIC vouchers to secure food through retail food stores that are authorized by their WIC state agency (Schultz et al., 2015). Participants use their WIC checks or

WIC electronic benefit transfer (EBT) cards to purchase specific items identified for each food package (Whaley, Ritchie, Spector, & Gomez, 2012). The different food packages and all formal rules and requirements for WIC, including in the Maximum Monthly Allowance (MMA) of Supplemental Foods for Children and Women with Qualifying Conditions in Food Package III, can be found in the March 11, 2014 *Federal Register* (Federal Register, 2014).

The WIC program is available in each of the 50 States, the District of Columbia, and 5 territories (American Samoa, Guam, the Northern Mariana Islands, Puerto Rico, and the Virgin Islands) in addition to 34 Indian tribal (Thorn et al., 2015). In 2014, over nine million women, infants, and children received WIC services; of these, over half (53%) were children, 23% were infants, and 24% were women (pregnant or lactating). Slightly less than half of the participants (41.6%) identified as being Hispanic/Latino. By race, 58.7% of all WIC participants identified as White only, 20.3% identified as Black or African American only, 11.1% identified as American Indian or Alaska Native only, and 4.1% identified as either Asian only or Native Hawaiian or Other Pacific Islander only. Two or more races were identified for 5.4% of WIC participants (Thorn et al., 2015).

The CDC examined trends in obesity prevalence during 2000-2014 among WIC participants aged 2-4 years using WIC program characteristic (PC) data. Overall, the prevalence of obesity in 2014 was 14.5% among WIC participants, with the prevalence highest among American Indians/Alaska Natives (18.0%) and Hispanics (17.3%), followed by non-Hispanic white (12.2%), non-Hispanic black (11.9%), or Asians/Pacific Islander (11.1%) (Pan et al., 2016).

Chiasson et al. (2016) examined the relationship between BMI and feeding practices, behaviors, and demographic characteristics among children enrolled in the New York State WIC

program as infants who remained in the program until their third birthday. By three years of age, 15.1% of the children were obese, with the prevalence of obesity lowest among participants whose mothers received the full breastfeeding food package. Hispanic children and those with birth weights of ≥ 4000 grams were significantly more likely to be obese than non-Hispanics and those with birthweights less than 4000 grams. These researchers suggested that WIC program can contribute in improving the health of children through nutrition education/counseling, breastfeeding support including peer counseling, and healthy food packages issued to all participants.

Lindsay et al. (2017) reported that, for mothers, WIC was an important source of information related to infant-feeding practices, including exclusive breastfeeding and appropriate introduction of solid foods during their pregnancies. Similarly, according to Chiasson et al. (2016), breastfeeding initiation increases after WIC peer counselor contacted participants.

Jacobson et al. (2015) compared breastfeeding behaviors in rural versus urban locations and provided insight into maternal demographics, health, and lifestyle behaviors among women enrolled in the Kansas WIC program in 2011. Results indicated that 74% of all mothers enrolled in WIC initiated breastfeeding, with urban and rural WIC participants differing significantly regarding socio-demographics, program participation, and health behaviors. Pregnant women who lived in rural areas had poorer health outcomes than pregnant women who lived in urban areas. Among urban WIC participants, breastfeeding initiation was highest among those who were Hispanic, were between 18 and 19 years of age, had more than a high school education, earned more than $10,000 per year, had enrolled in WIC during the first trimester, started prenatal care early in pregnancy, were non-smoking, and used multivitamins. Similar findings were observed among rural WIC participants, with the main difference being age, household

income, timing of prenatal care, and timing of WIC enrollment which were not significant in the predictive model for rural WIC participants.

Infant feeding practices have been shown to play a role in the weight status of both infants and children. Valencia et al. (2016) conducted a formative assessment with Latino mothers in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) to evaluate their knowledge, attitudes and behaviors regarding healthy growth for infants and their understanding of infant growth monitoring. Themes identified by the mothers included concern for underweight status, reports of limited conversations between mothers and healthcare providers regarding overweight status, and infant feeding practices/beliefs that may contribute to feeding behaviors associated with risk for excess weight gain during infancy. Growth charts were well received by the mother who were able to plot with modest accuracy. The researchers noted, however, that the effectiveness of growth plotting might be limited without refinement for health literacy and the provision of culturally-sensitive education in relation to feeding behaviors to support healthy infant growth. A common concern noted was the importance of infants becoming good eaters, a belief that promotes overfeeding behaviors. The researchers indicated that the mothers were not aware that formula supplementation may lead to overfeeding behaviors and contributes for infants' overweight risk.

Heinig et al. (2006) conducted focus groups to examine relationships among maternal beliefs, feeding intentions, and infant-feeding behaviors among 65 Women, Infants and Children-eligible (28 English-speaking and 37 Spanish-speaking) mothers. Although participants shared a common belief that breastfeeding was beneficial, many believed that early introduction of formula and solid foods was unavoidable in certain situations. The participants indicated medical providers and WIC staff were their primary sources of infant-feeding information. The

Spanish-speaking mothers reported they attempted to adhere to the guidance. In contrast, the English-speaking mothers reported they often ignored feeding advice if it was not perceived as working for the family's circumstances. Overall, the mothers indicated they believed providers would not understand that they were compelled to reject infant-feeding recommendations and thus they would not ask for assistance when facing difficulties. Instead, the mothers reported they relied on relatives and others for infant-feeding guidance. The researchers noted that educational efforts should acknowledge mothers' true circumstances, target support to each situation, and emphasize the health value of complementary foods rather than their association with infant motor development.

In sum, WIC program provides supplemental foods, nutrition education and breastfeeding counseling to low-income pregnant women, infants, and children up to their fifth birthday. Among WIC participants it has been found that Hispanics have a higher prevalence of childhood obesity. Infant feeding practices differed among races and ethnicities. Identifying and implementing programs that provide appropriate services that satisfy community needs is warranted.

Relationship between Feeding Practices and Childhood Obesity

Understanding how early dietary practices relate to weight status in infants may help dietitians and other health professionals develop programs to prevent obesity later in life. Sinigaglia et al. (2016) found that breastfeeding practices and longer duration of breastfeeding were associated with lower odds of excessive weight gain. Additional studies have shown that exclusively breastfeeding and/or longer duration of breastfeeding are associated with decreased rates of childhood obesity (Chiasson et al., 2016).

Moss & Yeaton (2014) examined data from the Early Childhood Longitudinal Study-Birth Cohort (ECL-B) of 2001to determine the relationship between breastfeeding and when complementary feedings were introduced on the weight status of children at 2 and 4 years of age. These researchers found that children who were not breastfed had a reduced odds of being obese when complementary feeding introductions were postponed until 4 months, with the odds of being obese further reduced when complementary feeding was delayed combined with breastfeeding. These findings indicated that breastfeeding and delaying the introduction of complementary feeding can have a positive impact on the weight status of children at both 2 and 4 years of age.

Feeding practices differ widely among Hispanic, African American and White mothers due to cultural influences, traditions, and knowledge of infant feeding standards (Zhou et al, 2014). In a cross-sectional survey of low-income, ethnically-diverse families with pre-school children aged 2-4 years who were participating in the Nashville Children Eating Well (CHEW) WIC program, Zhou et al. (2014) found that mixed breastfeeding and exclusive formula-feeding were more common among Hispanic children (67.4%) than either White (8.5%) or Black children (22.7%) ($p<.001$). Exclusive breastfeeding was found to have a protective effect on the BMI percentile among Hispanic pre-school children.

Davis et al. (2012) examined the effects of breastfeeding and SSB intake on the prevalence of overweight and obesity in Hispanic toddlers who were enrolled in the WIC program. The final sample included 1,483 Hispanic children who had height and weight data, had responses to all breastfeeding and dietary questions from the survey, were not preterm (≥ 36 weeks gestation), and were between 2 and 4 years of age. Results indicated that, when comparing participants who were not breastfed to participants who were breastfed for ≥ 12 months, the

breastfed infants had a 45% (OR = 0.55; 95% CI: 0.37-0.83; p=0.004) lower odds of being obese and a 28% lower odds of being overweight. Those who reported consuming no SSBs had a 31% (OR = 0.69; 95% CI: 0.47-1.00; p=0.05) lower odds of being obese. Finally, participants who were breastfed for ≥ 12 months and had no SSB intake, had a 61% (OR = 0.39; 95% CI: 0.19-0.80; p=0.01) decreased odds of having obesity.

Ehrenthal, Wu, and Trabulsi (2016) conducted a prospective cohort study that included over 2000 mother-infant dyads. Infants who were exclusively formula-fed or had mixed feeding at 2 months of age had a higher BMI Z-score and were more likely to be overweight at 4 years of age than infants who were exclusive breastfed.

Few studies have explored the relationship between environmental factors that influence childhood obesity and feeding practices among children. de la Torre et al. (2013) implemented a community-based participatory research approach to create a quasi-experimental intervention for over 5 years at two communities in California's Central Valley. Both communities were over 80% Mexican-origin. The intervention consisted of four main components including nutrition, physical activity, economic and art-community engagement. The researchers suggested that cultural adaptation and tailoring of nutrition messages are critical factors for success of nutrition education.

Lastly, Deming, Briefel, and Reidy (2014) conducted a cross-sectional study to describe feeding practices among children and infants participating in WIC program. These researchers analyzed 24-hour dietary recall data from the 2008 Feeding Infants and Toddlers Study (FITS), including WIC participants and nonparticipants. Results indicated that, when comparing WIC participants to nonparticipants, fewer WIC participants were breastfed ($p<.01$) and consumed any vegetables ($p<.05$), but more consumed 100% juice ($p<.05$). In addition, WIC toddlers were

more likely to consume any sweet comparing to nonparticipants ($p<.05$), prevalence was higher among SSB ($p<.01$).

Summary

Feeding practices have been shown to differ among people. The most common feeding practices among infants include exclusive breastfeeding, formula feeding, mixed feeding, and early introduction of complementary feeding. Race and/or ethnicity influence breastfeeding duration and initiation of complementary feeding. Adherence to complementary feeding guidelines are associated with a reduced prevalence of childhood obesity. Hispanic children have the highest prevalence rates of childhood obesity in the United States. Diet and other modifiable factors contributing to childhood obesity, such as SSB intake and physical activity, have been described to play a role in the prevalence of childhood obesity. The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) program provides supplemental foods, nutrition education, and breastfeeding counseling to low-income pregnant women, infants, and children up to their fifth birthday. Hispanic WIC participants have shown higher prevalence of childhood obesity when compared to other races. Research is needed to determine appropriate and efficient programs to promote nutrition education and physical activity among minority groups to reduce overweight and obesity rates among these groups. Furthermore, research is needed to examine feeding practices and obesity odds among WIC participants, especially among Hispanics.

CHAPTER 3

METHODOLOGY

The purpose of this study was to determine the relationship between infant feeding practices and the subsequent classification of obesity among Hispanic and non-Hispanic children 2- to 5-years of age served by the WIC program in Indiana between 2008 and 2012. This chapter describes the methods used to conduct the study.

Institutional Review Board

The Ball State University Institutional Review Board deemed this research project as exempt on February 6, 2018 (Appendix A-1). The researcher conducting this analysis completed the Collaborative Institutional Training Initiative training (Appendix A-2).

Subjects

The population for this study included all 225,827 infants and children who were enrolled and received benefits from the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in Indiana between 2008 and 2012. For the purpose of this study, the selection criteria included non-low birth weight infants (Hispanic and non-Hispanic) who were enrolled in the Indiana WIC program between 2008 and 2012 through at least their second birthday and who had a single race category marked on their initial WIC application form (n=117,846).In addition,

a narrower population was analyzed that only included participants (n=90,743) who marked one category (i.e., Hispanic [n=962] or non-Hispanic [n=89,781] as their ethnicity.

Letter of Permission

Data for this secondary analysis was obtained Nona Mahari, MD, MPH, Epidemiologist for the WIC/TEFAP Division of the Indiana State Department of Health (ISDH), on October 11, 2017 (Appendix B). The de-identified data was downloaded by Dr. Mahari from the Indiana WIC database and sent to the researchers via Excel spreadsheet in a series of zipped files over a secure server.

Methods

The study examined data from the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) for infants and children collected in Indiana from January 1, 2008 through December 31, 2012. This secondary data analysis was modeled after a study completed by Whaley et al. (2017) that examined the relationship between breastfeeding and the odds of childhood obesity in a large, primarily Hispanic WIC population in Southern California.

The data for this study was collected by Indiana state-employed Nutritionists or Registered Dietitians during the participants' enrollment or certification at WIC. Each individual who enrolls in WIC is assigned a unique identifier that follows that participant throughout the program. Variables obtained from the State for analysis include breastfeeding statues (i.e., infant exclusively breastfed, infant partially breastfed, infant formula fed), race, ethnicity, date of birth, gender, date of measurements, length in inches, weight in pounds and ounces, birthweight in

pounds and ounces, birth length in inches, breastfeeding duration, date supplemental food (formula) was begun, and age of the mother.

The data files obtained from the Indiana State Department of Health were uploaded into SPSS v.24 for matching, cleaning, and analysis. Prior to analyzing the data, the following steps were completed to prepare the data for analysis:

1. The age of the participant was found by subtracting the date of birth from the date of measurement (in seconds) and converting that value to years (by dividing to get minutes, hours, days, and finally years);
2. The length of the child at birth and at each subsequent measurement were converted from whole inches and eighths of inch to total inches of length;
3. The weight of the child at birth and at each subsequent measurement were converted from whole pounds and ounces to total weight in pounds;
4. The Body Mass Index (BMI) of participants was calculated at birth and for each subsequent measurement using the mathematical formula [(weight in pounds / 2.2) / (length in inches * 2.54 / 100)^2];
5. The subjects' weight in pounds and ounces was converted to the metric system in kilograms;
6. The data was examined for outliers and errors, including removing all subjects with a birth weight below 1,500 g or greater than 5,000 g, and subjects with lengths <18 inches or longer than 24 inches at birth;
7. Measurements where the length of the child decreased by more than ½ inch between measurements (i.e., any obvious data entry errors) were removed;

8. Those measurements where the height of the child was less than 30 inches or more than 50 inches for children between the ages of 2-to 5-years were removed from the data set;
9. The age of every child was converted to half months (e.g., 2.5 months, 3.5 months, etc.), the length to centimeters, and the weight to kilograms to match the CDC growth tables;
10. Using the BMI for age in months and the gender of the child, each measurement was matched to the CDC growth chart table to determine the child's percentile for age and gender. Obesity was determined by whether or not the measure exceeded the 95^{th} percentile for that age and gender. For children aged 24 months and younger, the child's weight was used, and for children older than 24 months, the BMI cutoff was used.
11. The unique WIC identifier was used to merge every record for each individual child over the entire time they were enrolled in WIC. This created one line of data per child for analysis.
12. Children who did not have any measurements between the ages of 2 through 5 years of age were removed from the data set.
13. Using the race-ethnicity code, two variables were created to reflect the race category and to indicate if the child was Hispanic. Any subjects who did not have an ethnicity category (Hispanic vs. non-Hispanic) were removed from the data set;

14. A dichotomous obesity variable (Yes/No) was created for each subject aged 2-to 5-years. This variable indicated if, at any time between the subject's 2nd and 5th birthday, the child's BMI was at or exceeded the 95th percentile.
15. When all of these steps were accomplished, the child's actual birthdate and their unique WIC identification number were deleted from the dataset.

Data Analysis

Data was analyzed using SPSS v.24 for Windows (SPSS, 2017). Descriptive statistics and frequency counts were run on all variables. Frequency counts (number and percent) were used to determine the demographics (i.e., race/ethnicity, age), anthropometrics (i.e., weight, height/length), breastfeeding incidence and duration, and date supplemental food (formula) was begun. A student's t-test was run to determine if there was a significant difference in the duration of exclusive breastfeeding and the risk of obesity. Chi square analyses were run to determine significant differences in the distribution of obesity by ethnicity and by type of infant feeding practice (ever breastfed vs. never breastfed) by ethnicity. A two-way Analysis of Variance (ANOVA) was conducted to examine differences in breastfeeding duration based on ethnicity (Hispanic or non-Hispanic) and obesity (yes or no). Logistic regression analysis was run to examine the relationship between breastfeeding duration and exclusivity of breastfeeding and the odds of obesity between the ages of 2-5 years. Cox Regression Analysis was performed to predict the onset of obesity between the ages of 2 and 5 years based on infant feeding method by race and ethnicity. Statistical significance was set at $p \leq 0.05$.

Summary

The purpose of this study was to examine the relationship of breastfeeding and obesity in Hispanic infant, and children aged 2-to-5 year served by WIC program in Indiana between 2008 and 2012. The study aimed to gain a better understanding of common feeding practices among Hispanics participants of WIC and its association with childhood obesity. Data from this secondary analysis was analyzed to determine the relationship between breastfeeding and the odds of childhood obesity among Hispanic and non-Hispanic between two and five years of age who were served by WIC in Indiana.

CHAPTER 4

RESULTS

The purpose of this study was to determine the relationship between infant feeding practices and the subsequent classification of obesity among Hispanic and non-Hispanic children 2- to 5-years of age served by the WIC program in Indiana between 2008 and 2012. This chapter presents the results of the study.

Study Population

Initially, over one million (n=1,205,384) records were obtained from the WIC Indiana database for children who were enrolled in the program between 2008 and 2012. Sorting the records by the unique WIC identifier resulted in a dataset that included information for 225,827 unique individuals. Delimiting the data to those who had visited WIC at least two times (with an average of 5.3 visits while enrolled in WIC) between their second through their fifth birthday reduced the dataset almost by half (52%) to 117,846 unique individuals.

Race

By race, the majority of participants indicated they were White (74.7%; n=87,991), followed by Black or African American (18.1%; n=21,330), Multiracial (5.2%; n=6,142), Asian (1.6%; n=1,837), American Indian or Alaskan Native (0.3%; n=381), or Native Hawaiian or Other Pacific islander (0.1%; n=165) (Table 1).

Table 1. Race categories as reported by participants at initial WIC enrollment (n=117,846).

Race	N	%
American Indian or Alaskan Native	381	0.3
Asian	1,837	1.6
Black or African American	21,330	18.1
Native Hawaiian or Other Pacific Islander	165	0.1
White	87,991	74.7
Other, multiracial	6,142	5.2

Ethnicity

By ethnicity, the majority (80.9%; n=95,385) of WIC participants identified as non-Hispanic (solely non-Hispanic, n=89,781; multi-ethnic, non-Hispanic, n=5,604). Approximately one in five (19.1%; n=22,461) participants identified as Hispanic (solely Hispanic, n = 962; multi-ethnic, including Hispanic, n = 21,490).

Because the primary focus of this study was to examine differences among those who were and were not Hispanic, and because it was hypothesized that the influence of cultural norms or feeding patterns would be stronger among those who identified solely as Hispanic or non-Hispanic, subjects were further classified by ethnicity into the following two categories (Narrow vs. Broad) for select analyses:

1) Narrow: This category (n=90,743) only includes individuals who solely indicated they were (n=962) or were not (89,781) solely Hispanic (i.e., no other ethnicity); and

2) Broad: This category (n=117,846) includes *all* individuals who indicated they were (n=22,461) or were not (n=95,385) Hispanic in any combination. By Hispanicity, this category includes those who reported being multi-ethnic,

including Hispanic (n=21,499) and those who indicated they were solely Hispanic (n=962). Among non-Hispanics, this category includes those who were multi-ethnic non-Hispanics (i.e., more than one ethnic category was selected, but none was Hispanic) (n=5,604) and those who only indicated "non-Hispanic" (n=89,781).

Consequently, the base population used in this study will vacillate between 90,743 ("Narrow" definition of Hispanic) and 117,846 ("Broad" definition of Hispanic), depending on the research question being addressed.

Table 2. Hispanic ethnicity of WIC participants by category (narrow vs. broad).

Category	N (%)
Narrow Definition	90,743 (100)
Hispanic only	962 (1.1)
Non-Hispanic only	89,781 (98.9)
Broad Definition	117,846 (100)
Hispanic	22,461 (19.1)
Hispanic only	962 (0.8)
Multi-ethnic, including Hispanic	21,499 (18.2)
Non-Hispanic	95,385 (80.9)
Non-Hispanic only	89,781 (76.2)
Multi-ethnic, but not including Hispanic	5,604 (4.8)

Classification of Obesity between Second and Fifth Birthday

Subjects were identified as having obesity if at least one BMI measurement reported on their WIC record, taken between their second and their fifth birthday, was at or above the 95th

percentile for children of the same age and sex on the 2000 CDC growth charts (https://www.cdc.gov/growthcharts/clinical_charts.htm). Overall, slightly more than one of every five (21.6%; n=25,492) participants was classified as having obesity at least one time between their second and fifth birthday; the majority of participants (78.4%; n=92,354) did not attain a weight that was at or above the 95th percentile between two and five years of age.

Breastfeeding Rates

The WIC records indicated 64.7% (n=76,266) of the participants were breastfed for at least some period of time ("ever breastfed"). Slightly more than one-third of the participants (35.3%; n=41,580) were never breastfed.

RQ#1. Infant Feeding Method and Risk of Obesity

The first research question in the study asked: What is the relationship between method of infant feeding and the risk of obesity among children aged 2- to 5-years served by WIC in Indiana between 2008 and 2012? The data was examined for infants who were "ever breastfed," by the duration an infant was exclusively breastfed, and by type of infant feeding practice (i.e., fully breastfed, partially breastfed, or fully formula fed).

Ever Breastfed vs. Never Breastfed

Based on the method of infant feeding coded in each participant's WIC records, 21.6% (n=16,055) of the 76,266 infants who were ever breastfed became obese at some point between their second and fifth birthday. In comparison, 22.7% (n=9,437) of the 41,580 infants who were never breastfed became obese. These results indicated that, when compared to infants who were "ever breastfed," infants who were *never* breastfed were significantly more likely to become obese at some point between their second and fifth birthday (X^2=42.9, df=1, $p < 0.001$) (Table 3).

Table 3. Risk of obesity among children aged 2-to 5-years served by WIC in Indiana between 2008 and 2012: "Ever breastfed" vs. "never breastfed."

Feeding Status Ever vs. Never Breastfed	Not Obese n (%)	Became Obese n (%)	Total n (%)
Never Breastfed	32,143 (77.3)	9,437 (22.7)	41,580 (35.3)
Breastfed	60,211 (78.9)	16,055 (21.1)	76,266 (64.7)
Total	92,354 (78.4)	25,492 (21.6)	117,846 (100)

$X^2 = 42.9$, $df = 1$, $p < 0.001$

Duration of Exclusive Breastfeeding and Risk of Obesity

Overall, the mean duration of exclusive breastfeeding among those who subsequently never became obese (n=92,354) was 3.5 ± 6.4 months. In contrast, the mean duration of exclusive breastfeeding among those who subsequently became obese between their second and fifth birthday (n=25,492) was 2.8 ± 5.6 months, a difference of 0.6 months (95% CI: 0.56-0.72 months). The results were significant, with the longer an infant was exclusively breastfed, the lower their risk for subsequently being classified as obese ($t = 15.6$, $df=45,564$, $p < 0.001$) (Table 4).

Table 4. Duration in months an infant was exclusively breastfed and the risk of obesity.

	Risk of Obesity	n	Mean	SD	Mean Diff.	95% CI	p
Breastfeeding Duration in Months	Not Obese	92,354	3.5	6.4	0.7	0.56-.72	<0.001
	Became Obese	25,492	2.8	5.6			

$t=15.6$, $df=45,564$, $p < 0.001$

Type of Infant Feeding and Risk of Obesity

The WIC program categorizes infant feeding practices at the initial enrollment into one of three types –fully/exclusively breastfed (IBE), partially breastfed (IBP), or fully formula fed (IFF). Of the 117,846 unique individuals included in this study, 1,925 initially enrolled in WIC after one year of age. These individuals, classified by WIC as "children," were excluded from the following analysis. Of the remaining 115,921 individuals who enrolled in WIC while an infant, the majority were formula fed (IFF: 71.3%; n=82,677), with the remaining infants either exclusively breastfed (IBE: 14.8%; n=17,167) or partially breastfed (IBP: 13.9%; n=16,077) (Table 5).

Table 5. Initial method of infant feeding reported during enrollment at WIC.

Method of Infant Feeding	Total Population N (%)	Percent (%)	Revised Population N (%)	Percent (%)
C – Children	1,925	1.6	-	-
IBE – Infant Exclusively Breastfed	17,167	14.6	17,167	14.8
IBP – Infant Partially Breastfed	16,077	13.6	16,077	13.9
IFF – Infant Formula Fed	82,677	70.2	82,677	71.3
Total	117,846	100.0	115,921	100.0

When the type of initial feeding practice (i.e., fully breastfed, partially breastfed, or fully formula fed) was compared to the risk of obesity between the subject's second and fifth birthday, the partially breastfed infants had the highest rate of subsequent obesity (23.2%; n=3,723 of 16,077 IBP), followed by formula fed infants (22.6%; n=18,656 of 82,677 IFF). Exclusively

breastfed infants (IBE) had a significantly lower rate of subsequent obesity (15.9%; n=2,733 of 17,167 IBE) than either the IBP or IFF infants (X^2= 394.4; *df* = 2; p <0.001 (Table 6).

Table 6. Risk of obesity among children aged 2-to 5-years served by WIC in Indiana between 2008 and 2012 by type of infant feeding practice (n=115,921).

Infant Feeding Practice	Not Obese n (%)	Became Obese n (%)	Total n (%)
IBE	14,434 (84.1) AR = 19.8	2,733 (15.9) AR = -19.8	17,167 (14.8)
IBP	12,354 (76.8) AR = -5.0	3,723 (23.2) AR = 5.0	16,077 (13.9)
IFF	64,021 (77.4) AR = -11.8	18,656 (22.6) AR = 11.8	82,677 (71.3)
Total	90,809 (78.3)	25,112 (21.7)	115,921 (100)

X^2 = 394.4, df = 2, p < 0.001.
AR = Adjusted Residuals.

Summary

In summary, with regards to the first research question, when compared to infants who were ever breastfed, infants who were never breastfed had a statistically higher risk of obesity at some point between their second and fifth birthday. Secondly, breastfeeding for a longer duration was associated with a reduced risk of subsequent obesity. Lastly, the highest rate of subsequent obesity was seen in infants who were partially breastfed, followed by infants who were formula fed; the risk of subsequent obesity was lowest in those infants who were exclusively breastfed.

RQ#2. Infant Feeding Method and the Risk of Obesity by Ethnicity

The second research question in the study asked: Is there a difference by ethnicity (Hispanic vs. non-Hispanic) between the method of infant feeding and the risk of having obesity among children aged 2- to 5-years who were served by WIC in Indiana between 2008 and 2012? The data was examined for infants who were "ever breastfed," by the duration an infant was exclusively breastfed, and by the type of infant feeding practice (i.e., fully breastfed, partially breastfed, or fully formula fed).

Ever Breastfed vs. Never Breastfed by Ethnicity (Hispanic vs. Non-Hispanic)

Using the broad classification (i.e., Hispanic in any combination), 22,461 children were classified as Hispanic. Almost eighty percent (79.8%; n=17,921) of the Hispanic infants were breastfed. Of these, 5,021 (28.0%) became obese at some point between their second and fifth birthday. In comparison, among the 20.2% (n=4,540) of Hispanic infants who were never breastfed, 30.9% (n=1,403) became obese at some point between their second and fifth birthday. Chi square analysis indicated that breastfed Hispanic infants were significantly less likely to become obese at some point between their second and fifth birthday than non-breastfed Hispanic infants (X^2= 14.8, df = 1, p < 0.001) (Table 7).

Table 7. Risk of obesity among Hispanic children aged 2-to 5-years served by WIC in Indiana between 2008 and 2012who were "ever breastfed" (n=22,461).

Hispanic Ever Breastfed	Not Obese n (%)	Became Obese n (%)	Total n (%)
Never Breastfed	3,137 (69.1)	1,403 (30.9)	4,540 (20.2)
Ever Breastfed	12,900 (72.0)	5,021 (28.0)	17,921 (79.8)
Total	16,037 (71.4)	6,424 (28.6)	22,461 (100)

X^2= 14.8, df = 1, p < 0.001.

In this study, 95,385 children were classified as non-Hispanic. In comparison to the rate among Hispanic infants (i.e., 79.8%), only 61.1% (n=58,345) of the non-Hispanic infants were breastfed. Of these, only 18.9% (n=11,034) (compared to 28.0% among Hispanics) subsequently became obese at some point between their second and fifth birthday. In comparison, among the non-Hispanic infants who were never breastfed (38.8%; n=37,040), 21.7% (n=8,034) became obese at some point between their second and fifth birthday. Despite the lower percent of non-Hispanic infants who were ever breastfed, the relationship between breastfeeding and a reduced risk for obesity remained apparent, as Chi square analysis indicated non-Hispanic infants who were ever breastfed were significantly less likely to become obese at some point between their second and fifth birthday than non-breastfed non-Hispanic infants (X^2=109.3, *df*=1, p < 0.001) (Table 8).

Table 8. Risk of obesity among non-Hispanic children aged 2-to 5-years served by WIC in Indiana between 2008 and 2012 who were "ever breastfed" (n=95,385).

Non-Hispanic Ever Breastfed	Not Obese n (%)	Became Obese n (%)	Total n (%)
Never Breastfed	29,006 (78.3)	8,034 (21.7)	37,040 (38.8)
Ever Breastfed	47,311 (81.1)	11,034 (18.9)	58,345 (61.2)
Total	76,317 (80.0)	19,068 (20.0)	95,385 (100)

X^2= 109.4, df = 1, p < 0.001.

Duration of Exclusive Breastfeeding and Risk of Obesity by Ethnicity

Overall, descriptive data indicates Hispanic infants (n=22,461) were breastfed longer than non-Hispanic infants (n=95,385) (5.4 ± 7.5 months vs. 2.9 ± 5.9 months). In addition, infants who were never classified as obese between two and five years of age (n=92,354) were breastfed longer (3.5 ± 6.5 months) than those who would subsequently be classified as obese (n=25,492) who breastfed, for average, 2.8 ± 5.6 months (Table 9; Figure 1).

Table 9. Duration in months an infant was exclusively breastfed and risk of obesity by ethnicity.

Breastfeeding Duration, Months	Risk of Obesity	n	Mean	SD
Hispanic	Not Obese	16,037	5.6	7.7
	Became Obese	6,424	4.8	6.9
	Total	22,461	5.4	7.5
Non- Hispanic	Not Obese	76,317	3.0	6.1
	Became Obese	19,068	2.2	5.0
	Total	95,385	2.9	5.9
Total	Not Obese	92,354	3.5	6.5
	Became Obese	25,492	2.8	5.6
	Total	117,846	3.3	6.3

This observation held true for both Hispanics and non-Hispanics, where a lower incidence of obesity was consistently associated with longer breastfeeding experience, as can be seen in Figure 1.

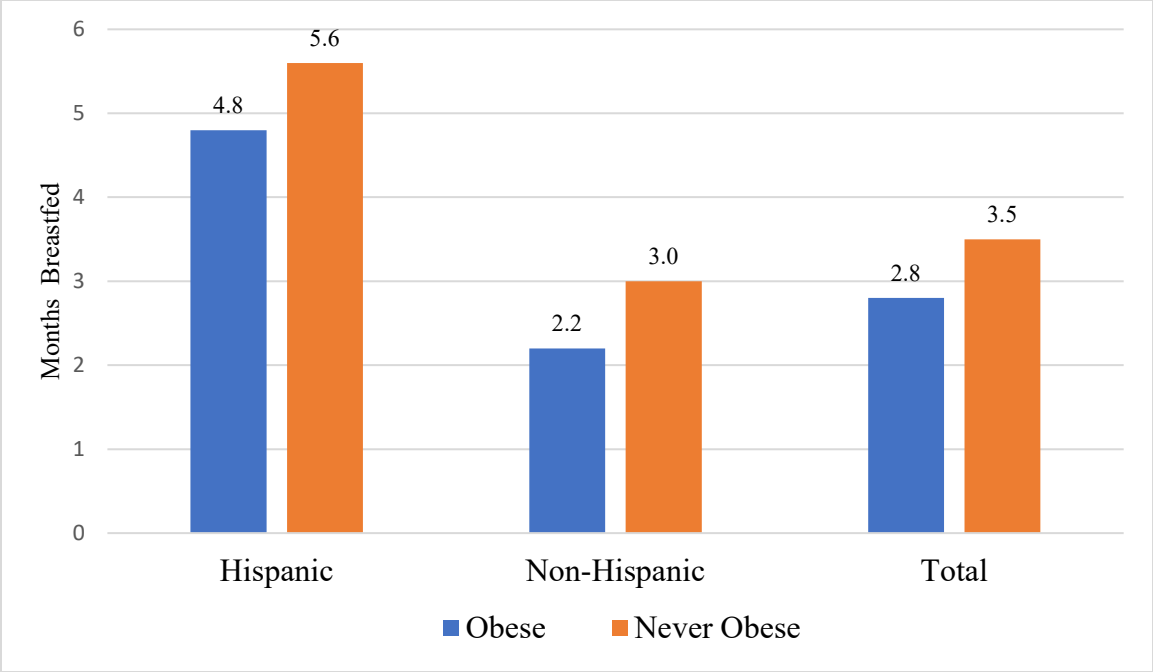

Figure 1. *Mean duration of exclusive breastfeeding in months and subsequent obesity among children aged 2-to 5-years, by ethnicity (Hispanic vs. non-Hispanic) (n=117,846).*

The initial Analysis of Variance (ANOVA) and subsequent post-hoc tests that examined the relationship between breastfeeding duration and risk of obesity by ethnicity had an assumption violation (Levene's Test of Equality of Error Variances; F = 1169.4; n=117,842; p <0.001). To address this violation, the statistician randomly selected a sample that included an equal number of subjects based on the smallest number in any cell in the original analysis (in this case, 243 Hispanic infants who subsequently became obese). The statistician did this using the narrow definition of Hispanic (i.e., only individuals who indicated they were solely Hispanic were included in this analysis). This random selection resulted in an equal number of subjects in each cell, as the F test is conditionally robust for the homogeneity of variance assumption when group sizes are equal or approximately equal (Pituch, K. A. & Stevens, J. P., 2016, Applied multivariate statistics for the social sciences, 6th Ed., p. 220). Consequently, the random

selection, done in a stratified approach, resulted in 243 subjects randomly selection from the larger sample within each cell of the ANOVA.

Descriptive statistics for the stratified random sample indicated the mean breastfeeding duration remained highest among Hispanic participants who never became obese before their fifth birthday (5.0 ± 8.1 months) (Table 10). Hispanic participants that became obese before their fifth birthday had a lower mean breastfeeding duration (3.7 ± 5.9 months). Non-Hispanics who became obese before their fifth birthday had the lowest mean breastfeeding duration (2.2 ± 5.2 months), while non-Hispanics who never became obese had a mean breastfeeding duration of 2.8 ± 5.3 months. These data can be seen graphically in Figure 2.

Table 10. Breastfeeding duration of an infant in months and the risk of obesity among Hispanics and non-Hispanics using a stratified sample with equal n's (n=972).

Breastfeeding Duration, Months	Risk of Obesity	n	Mean	SD
Hispanic	Not Obese	243	5.0	8.1
	Became Obese	243	3.7	5.9
	Total	486	4.3	7.1
Non- Hispanic	Not Obese	243	2.8	5.3
	Became Obese	243	2.2	5.2
	Total	486	2.5	5.2
Total	Not Obese	486	3.9	6.9
	Became Obese	486	3.0	5.6
	Total	972	3.4	6.3

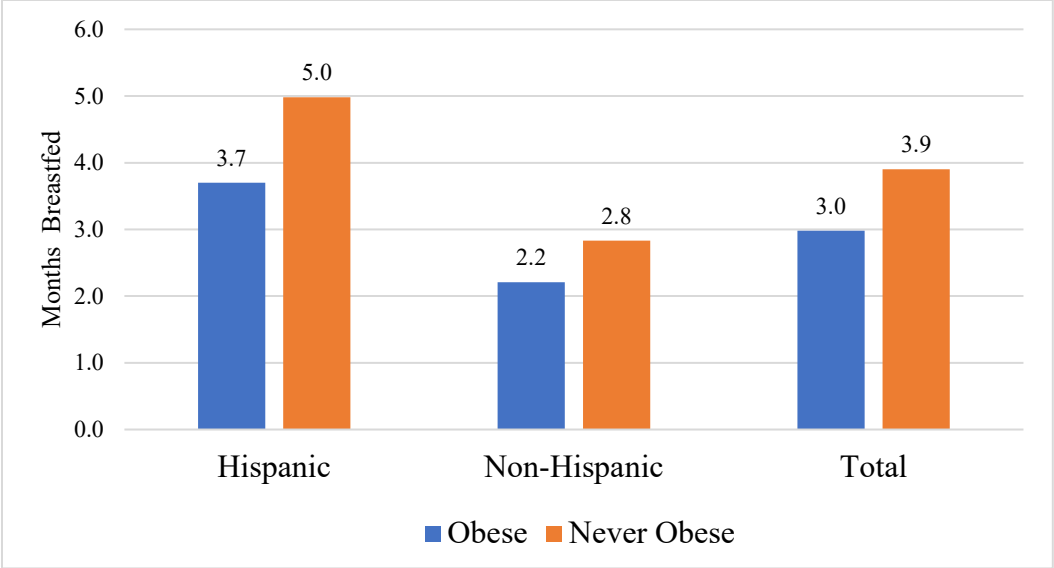

Figure 2. *Mean duration of exclusive breastfeeding in months and subsequent obesity among children aged 2-to 5-years, by ethnicity in the randomly stratified sample with equal n's (n=972).*

The mean number of months a mother exclusively breastfed, from shortest to longest duration (Figure 3), clearly shows the difference between Hispanics and non-Hispanics.

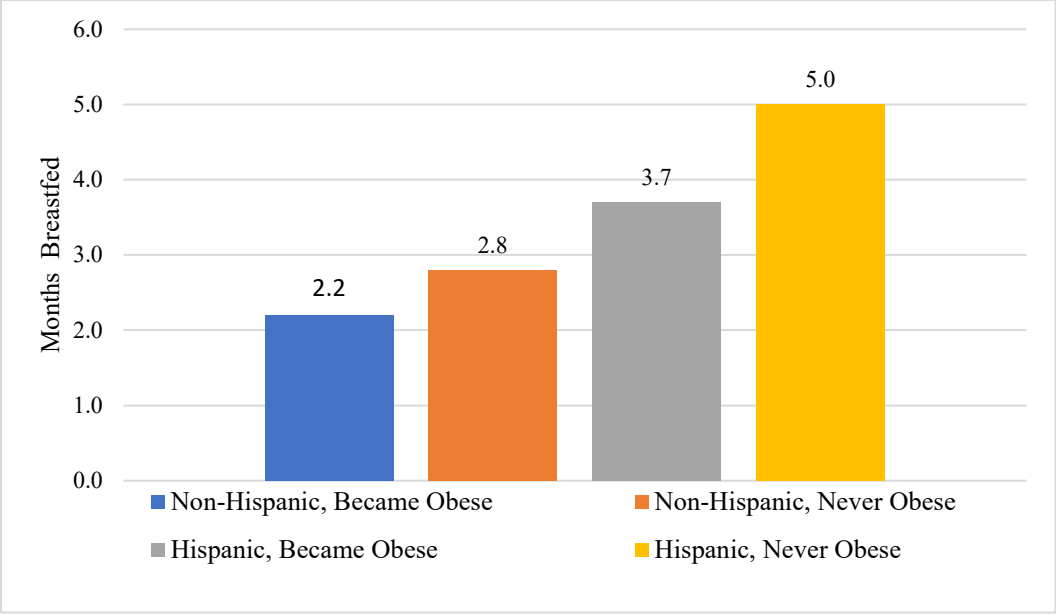

Figure 3. *Mean breastfeeding duration in months and obesity outcome among WIC participants in Indiana between 2008 and 2012 in ascending order using the narrow definition of ethnicity (n=972).*

A two-way ANOVA for that examined the duration of breastfeeding by ethnicity (Hispanic and non-Hispanic) with equal n's indicated Hispanic infants (n=486) were breastfed almost two months longer than non-Hispanic infants (n=486) (4.3 ± 7.1 months vs. 2.5 ± 5.2 months) ($F=20.73$, $df=1$, $p < 0.001$). In addition, infants who were never classified as obese between two and five years of age (n=486) were breastfed one month longer (3.9 ± 6.5 months) than those who would subsequently be classified as obese (n=486; 3.0 ± 5.6 months) ($F=0.018$; $df=1$, $p = 0.018$) (Table 11).

Table 11. Breastfeeding duration in months and risk of obesity using the narrow definition of Hispanic and a stratified sample (n=243 per cell; n=972).

Breastfeeding Duration, Months	Mean	St. Error	95% CI	F	p
Hispanic vs. non-Hispanic					
• Non-Hispanic	2.5	0.3	2.0-3.1	20.73	**< 0.001**
• Hispanic	4.3	0.3	3.8-4.9		
Obese vs. Not Obese					
• Not Obese	3.9	0.3	3.3-4.5	5.60	**0.018**
• Became Obese	2.9	0.3	2.4-3.5		
Interaction: Hispanic vs. non-Hispanic x Obese during Ages 2 through 5 years					
• Non-Hispanic+ Not Obese	2.8	0.4	2.0-3.6	0.695	0.405
• Non-Hispanic + Obese	2.2	0.4	1.4-3.0		
• Hispanic + Not Obese	5.0	0.4	4.2-5.8		
• Non-Hispanic + Obese	3.7	0.4	2.9-4.5		

While the main effects of ethnicity and obesity were both statistically significant based on the length of exclusive breastfeeding, the interaction between ethnicity, length of exclusive breastfeeding, and subsequent obesity between two and five years of age, was not significant

(F=0.695, df=1, p=0.405). Simply put, there was no difference in the relationship between the duration of exclusive breastfeeding and the incidence of obesity between Hispanics and non-Hispanics (Table 11).

Type of Infant Feeding and Risk of Obesity by Ethnicity (Hispanic vs. non-Hispanic)

The relationship between the method of infant feeding and the subsequent risk of obesity among children aged two to five years was examined by ethnicity and type of infant feeding practice (i.e., IBE: infants breastfed exclusively; IBP: infants breastfed partially; IFF: infants formula fed). A series of Chi square analyses were run to identify differences.

Results indicated that Hispanic infants who were formula-fed (IFF) had the highest percent of subsequent obesity (30.2%; n=3,580) compared to any other type of infant feeding practice among either Hispanics or non-Hispanics. Hispanic participants who were exclusively breastfed (IBE) had the lowest percent of subsequent obesity (21.9%; n=676). The rate of obesity among Hispanic infants who were partially breastfed (IBP) was 28.9% (n=2,047) (X^2= 83.015; *df* = 2; p<0.001), almost as high as the rate among the formula fed infants (Table 12). The adjusted standardized residuals (AR) indicate the difference between the expected count and the actual count relative to the sample, with any AR greater than 2.0 considered statistically significant. In this study, with the AR as evidence, exclusive breastfeeding among Hispanic infants was associated with a significantly reduced risk for obesity (AR = -8.9) between the ages of 2 and 5 years; in contrast, formula feeding was associated with a significantly increased risk for obesity between the ages of 2 and 5 years (AR = 5.6).

Table 12. Relationship between the risk of obesity among Hispanic children aged 2-to 5-years served by WIC in Indiana between 2008 and 2012 by type of infant feeding practice (n=22,053).

Infant Feeding Practice	Not Obese n (%)	Became Obese n (%)	Total n (%)
IBE	2,415 (78.1) AR = 8.9	676 (21.9) AR = -8.9	3,091 (14.0)
IBP	5,046 (71.1) AR = -0.6	2,047 (28.9) AR = 0.6	7,093 (32.2)
IFF	8,289 (69.8) AR = -5.6	3,580 (30.2) AR = 5.6	11,869 (53.8)
Total	15,750 (71.4)	6,303 (28.6)	22,053 (100)

X^2 = 83.0, df = 2, p < 0.001.
AR = Adjusted Residuals.

Similar findings were observed among non-Hispanic participants, with the type of infant feeding practice statistically associated with obesity (X^2= 338.644, *df* = 2; p < 0.001) (Table 13). The percent of obesity was lowest among non-Hispanics who were IBE (exclusively breastfed) (14.6%; n=2,057; AR = -17.4). As was true for Hispanics, the rate of obesity was highest among non-Hispanic infants who were IFF (formula fed) (21.3%; n=15,076; AR = 16.8). In contrast with Hispanics, the obesity rate for non-Hispanic infants who were IBP (partially breastfed) was (18.7%; n=1,676; AR = -3.4), significantly lower than one would have expected by chance. (Table 13).

Table 13. Relationship between the risk of obesity among non-Hispanic children aged 2-to 5-years served by WIC in Indiana between 2008 and 2012 by type of infant feeding practice (n=93,868).

Infant Feeding Practice	Not Obese n (%)	Became Obese n (%)	Total n (%)
IBE	12,019 (85.4) AR = 17.4	2,057 (14.6) AR = -17.4	14,076 (15.0)
IBP	7,308 (81.3) AR = 3.4	1,676 (18.7) AR = -3.4	8,984 (9.6)
IFF	55,732 (78.7) AR = -16.8	15,076 (21.3) AR = 16.8	70,808 (75.4)
Total	75,059 (80.0)	18,809 (20.0)	93,868 (100)

$X^2 = 338.6$, $df = 2$, $p < 0.001$.
AR = Adjusted Residuals.

Figure 4 depicts the rate of obesity among both Hispanic and non-Hispanic infants between the ages of two and five years. Infants who were exclusively breastfed had a significantly lower rate of subsequent obesity among both Hispanics ($X^2 = 83.0$; $p < 0.001$) and non-Hispanics ($X^2 = 338.6$; $p < 0.001$).

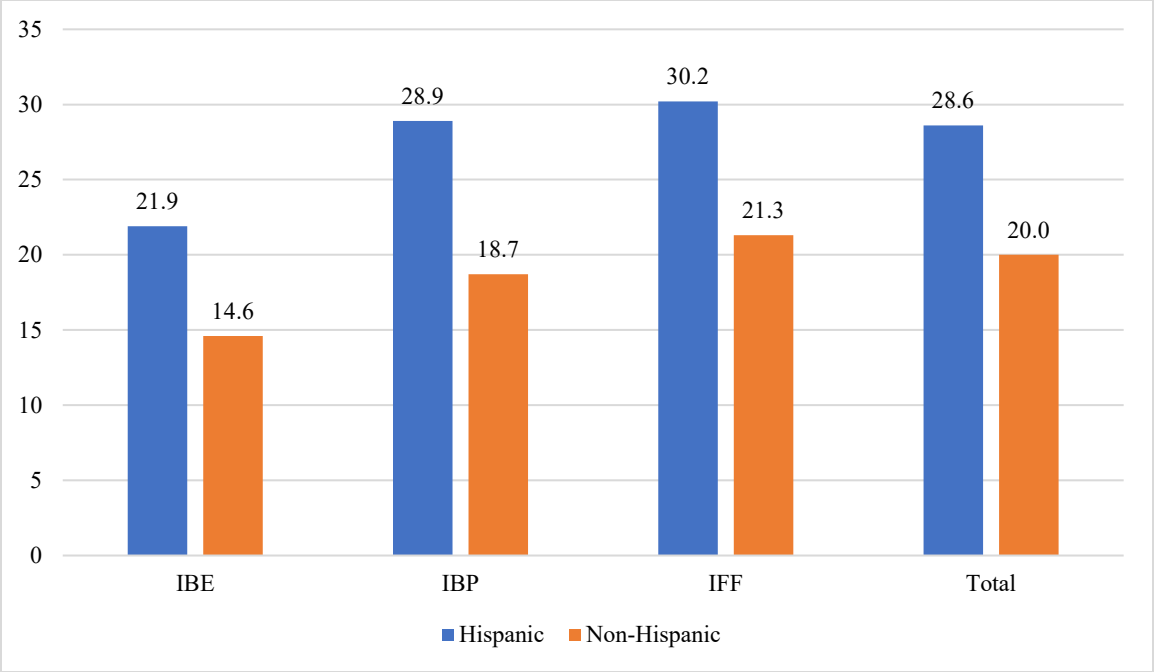

Figure 4. *Percent of subsequent obesity among Hispanic and non-Hispanic infants based on infant feeding method (IBE=Infant breastfed; IBP=Infant partially breastfed; IFF=Infant formula fed) among children aged 2-to 5-years (n=117,846)*

Summary

In summary, the second research question examined differences between the method of infant feeding and the subsequent classification of obesity by ethnicity. Results indicated Hispanic infants were exclusively breastfed significantly longer than non-Hispanic infants. Both Hispanic and non-Hispanic infants who were ever breastfed were significantly less likely to become obese at some point between their second and fifth birthday than non-breastfed infants. Among both Hispanic and non-Hispanic infants, the longer an infant exclusively breastfed, the lower the incidence of obesity. Among both Hispanics and non-Hispanics, the highest rate of subsequent obesity was observed among infants who were formula-fed, followed by infants who were partially breastfed. Among both Hispanic and non-Hispanic infants, the lowest rate of subsequent obesity was observed among infants who were exclusively breastfed.

RQ#3. Predicting obesity between 2 to 5 years by infant feeding practice

The third research question in the study addressed the question: Can the onset of obesity between the ages 2 and 5 years be predicted based on the type of infant feeding practice among Indiana WIC participants between 2008 and 2012? The data was examined both overall and by ethnicity (Hispanic vs. Non-Hispanic).

Predicting Obesity between Two and Five Years of Age by Infant Feeding Method

Logistic regression analysis was employed to predict the probability that a participant (n= 21,989) would become obese at any time between their second and fifth birthday. The predictor variables were IBE and IBP. A test of the full model compared to an Omnibus Test of Model Coefficients with intercept only was statistically significant (X^2 = 107.510, *df* = 3, p<0.001). The model correctly classified, with a 83.7% probability, participants who would not become obese. Interpreted another way, the data was able to predict with a 16.3% probability whether or not a WIC participant would become obese at any time between their second and fifth -birthday (Table 14).

Table 14. Logistic regression predicting the risk of obesity among 2-to 5-year olds served by WIC in Indiana between 2008 and 2012 (n=21,989).

	Risk of obesity	n	Overall Percentage	Std Error	β	Wald test	p	NagelkerkeR^2
Infant feeding method; IBE, and IBP	Not Obese	18,414	83.7	.018	-1.639	8043.666	0.001	.008
	Became Obese	3,575	16.3					

X^2 = 107.510, df = 3, p < 0.001

When ethnicity (Hispanic versus Non-Hispanic), breastfeeding duration in months, and IBE versus IBP were included as predictor variables in the logistic regression analysis, the odds ratio (OR) of becoming obese at any time between a participant's second and fifth birthday increased by 38% if the child was Hispanic (OR = 1.383, [95% CI: 1.076 – 1.777], p=0.011). Similarly, the OR of obesity increase by 26.7% if an infant was partially breastfed (IBP) (OR = 1.267, [95% CI: 1.177 – 1.365] p < 0.001). Lastly, it was observed that for each month of breastfeeding, the OR of obesity dropped by 1.5% (OR = 0.985, [95% CI: 0.980 – 0.990], p < 0.001) (Table 15).

Table 15. Logistic regression predicting the risk of obesity among 2-to 5-year olds served by WIC in Indiana between 2008 and 2012, from ethnicity, breastfeeding duration in months, and infant feeding method (n=21,989).

	β	Std Error	Wald test	OR	95% CI	p
Non-Hispanic vs. Hispanic	.324	.128	6.432	1.383	1.076-1.777	0.011
Breastfeeding duration in months	-.015	.003	35.783	.985	.980-.990	<0.001
IBE vs. IBP	.237	.038	38.981	1.267	1.177-1.365	<0.001

Summary

In summary, the third research question examined if the onset of obesity between the ages of 2 and 5 years could be predicted based on the type of infant feeding practice among Indiana WIC participants between 2008 and 2012. The data was examined both overall and by

ethnicity (Hispanic vs. Non-Hispanic). The data was able to predict with a 16.3% probability whether or not a WIC participant would become obese at any time between their second and fifth –birthday. Logistic regression analysis indicated the odds of becoming obese at any time between a participant's second and fifth birthday increased by 38% if the child was Hispanic. Similarly, the OR of obesity increase by 26.7% if an infant was partially breastfeed. Lastly, for each month of breastfeeding, the odds of obesity dropped by 1.5%.

Summary

Results from this secondary data analysis from the Indiana WIC program between 2008 and 2012 revealed that only 64.7% of WIC participants in Indiana were ever breastfed, lower than the Healthy People 2020 goal of 81.9%. Participants who were breastfed had the lowest prevalence of obesity (21.6%). Infants who never became obese were breastfed longer than those who subsequently became obese between their second and fifth birthday. Overall, participants who were exclusively breastfed had the lowest rate of subsequent obesity between the ages of two and five (15.9%). Infants who were partially breastfed had the highest obesity rates (23.2%). The rate of subsequent obesity among infants who were formula fed was 22.6%. By ethnicity, Hispanics who were never breastfed had higher rates of obesity (30.9%) than non-Hispanics who were never breastfed (21.7%). Hispanics who were breastfed had higher obesity rates (28.0%) than non-Hispanic who were breastfed (18.9%). Breastfeeding longer duration was longest among Hispanic participants who never became obese (5.6±6.06) and shortest among non-Hispanics who became obese (2.2±5.87). Both Hispanic and non-Hispanic participants who were fully formula fed (IFF) had the highest obesity rates (30.2% vs. 21.3%), respectively, when compared to partially formula fed or breastfed infants. Exclusively breastfed (IBE) Hispanic and non-Hispanic participants had the lowest obesity rates (21.9% vs. 14.6%). Logistic regression

analysis indicated a 16.3% probability a WIC participant will become obese at any time between their second and fifth. The OR of becoming obese during this time increased by 38% if the child was Hispanic, and by 26.7% if an infant was partially breastfed. Results indicated that for each month of breastfeeding, the OR of becoming obese dropped by 1.5%. Overall, these results indicate there is a need for an increased awareness of health outcomes of infant feeding practices, particularly, the role infant feeding practices play in childhood obesity among WIC participants in Indiana.

CHAPTER 5

DISCUSSION

The purpose of this study was to determine the relationship between infant feeding practices and the subsequent classification of obesity among Hispanic and non-Hispanic children 2 to 5 years of age served by the WIC program in Indiana between 2008 and 2012. This chapter discusses the results and implications of the findings of this study.

Infant Feeding Method

Across the globe, breastfeeding is the recommended method of infant feeding (Smith et al., 2016). Breast milk—the optimal food for infants—and breastfeeding, have been found to be beneficial for both mother and infant (Jacobson et al., 2015), particularly for minority women (Jones et al., 2015).The results of this study indicated that, between 2008 and 2012, only 64.7% of WIC participants in Indiana were ever breastfed, lower than the Healthy People 2020 goal of 81.9% (ODPHP, 2017) and, according to the *2018 Breastfeeding Report Card,* lower than the current rate in both the United States (83.2%) and Indiana across all populations (78.8%) (CDC, 2018a).At the time the participants in this study enrolled in WIC, the majority were being fully formula fed (71.3%), with fewer infants being either fully (14.8%), or partially (13.9%), breastfed.

High breastfeeding initiation rates in the United States suggest that most mothers want to breastfeed and start out doing so (CDC, 2018b). However, despite the recommendations, the exclusive breastfeeding rates remain low, particularly among these Indiana WIC recipients, suggesting that mothers may not be getting the support they need from health care providers, family members, and employers to meet their breastfeeding goals (CDC, 2018b). Additional research must be conducted to determine why the rate of ever breastfed infants among WIC participants in Indiana remains lower than the state and national averages and lower than the national goal.

Infant Feeding Method and Risk of Obesity

Infant feeding practices, particularly the choice between breastfeeding, formula feeding, and mixed feeding, influence body composition, overweight, and obesity later in life (Gale et al., 2012; Appleton et al., 2018, van Eijsden, Meijers, Jansen, de Kroon, & Vrijkotte, 2015). In the present study, participants who were ever breastfed had a significantly lower prevalence of obesity (21.1%) compared to participants who were never breastfed (22.7%). Whaley et al. (2017) found that breastfeeding contributed to reductions in the development of childhood obesity, and initiating breastfeeding was associated with reduced obesity at age 2-5 years, particularly when no formula was introduced. The results of this study support those of Whaley et al. (2017). Early initiation of breastfeeding and exclusive breastfeeding in the first month of life can have a positive impact on mortality (Mathu & Dhingra, 2013; Khan et al., 2015), with breastfeeding one of the most effective interventions to prevent mortality in children under the age of five (Holla-Bhar et al., 2015).

Wang et al. (2017) examined the effects of breastfeeding duration on the development of childhood obesity from 24 months through sixth grade. Data from a selected cohort of 1,234 children and their mothers was abstracted from the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development (SECCYD) for analysis. Data was analyzed using logistic regression models and generalized estimating equation (GEE). Logistic regression showed that breastfeeding at month 1 was associated with 53% (OR: 0.47, 95% CI: 0.30–0.73) and 47% (OR: 0.53, 95% CI: 0.36–0.78) decreased risks for childhood obesity at grades 1 and 6, respectively. The GEE analysis showed that breastfeeding at 1 month reduced risk for childhood obesity by 36% (95% CI: 0.47–0.88) from ages 24 months through grade 6. Regarding breastfeeding duration, more than 6 months (vs. never) was associated with a decreased risk for childhood obesity by 42% (OR: 0.58, 95% CI: 0.36–0.94).

In the present study, children who never became obese between their second and fifth birthdays were breastfed significantly longer (3.5 ± 6.4 months) than infants who subsequently became obese (2.8 ± 5.6 months). Higher rates of obesity were also seen in those infants who were partially (23.2%) and fully formula-fed (22.6%) compared to infants who were exclusively breastfed (15.9%). This raises the question whether or not partially breastfed infants are being fed excess calories. Mothers partially breastfeeding may not take into consideration both formula and breastmilk calories resulting in overfeeding their infants. These results suggest dietitians and other health professionals need to promote appropriate and safe feeding practices among infants and children.

An association between breastfeeding and childhood obesity can be explained by breastfeeding's biological mechanisms. Breast milk contains a lower number of calories and nutrients such as sugar, water, protein, and fat, and includes bioactive substances such as leptin

and ghrelin (Wang et al., 2017). Davis, Li, Adams-Huet, & Sandon (2017) emphasized the importance of identifying feeding practices in infancy which could prevent the onset of overweight.

Infant Feeding Method and Risk of Obesity by Ethnicity

Ethnicity has been shown to play a significant role in weight status (Gaffney, Brito, Kermer, & Kitsantas, 2018), particularly when examined by infant feeding practices (Beck, Hoeft, Takayama & Barker, 2018). In the present study, Hispanics who were "ever breastfed" had a lower rate of obesity (28.0%) than Hispanics who were never breastfed (30.9%). While the incidence of obesity was also lower among non-Hispanics who were "ever breastfed" (18.9%), compared to non-Hispanics who were never breastfed (21.7%), the overall rate of obesity was significantly higher among Hispanics in both groups. Hohl et al. (2016) argued that increased acculturation among Hispanics in the United States has been associated with the changes in their breastfeeding behaviors. Breastfeeding duration has been linked to decrease among immigrants. Schmied et al. (2012) found for each year a migrant woman resides in a new country, breastfeeding duration decreases. Racial and ethnic disparities regarding the causes of overweight in children are a complex subject (Liu et al., 2015).

In this study, the duration of breastfeeding impacted the risk of an infant subsequently becoming obese, particularly among Hispanics. Hispanic infants who never became obese breastfed significantly longer (5.0 ± 8.1 months) than Hispanic infants who became obese (3.7 ± 5.9 months). Similarly, non-Hispanic infants who never became obese breastfed for a significantly longer duration (2.8 ± 5.3 months) than non-Hispanic infants who subsequently became obese at some point between their second and fifth birthday (2.2 ± 5.2 months).

In a cross-sectional analysis using data from the 2003-2012 National Health and Examination Survey (NHANES), Davis et al. (2017) compared infant and toddler anthropometric measurements, feeding practices and mean nutrient intakes by race/ethnicity and income. The study analyzed data from 3669 infants and toddlers aged 0-24 months. Researchers found that rates of overweight were higher among Mexican-American participants (p=0.002), with feeding practices differing among groups based on race/ethnicity. Researchers indicated that 71% of participants (n=2624) received breast milk. Of the 3,628 infants and toddlers for whom data were available, 13% had a weight-for-length ≥95thpercentile, indicating overweight. A total of 26.9% were non-Hispanic whites, 39.3% were Mexican-Americans and 19.5% were non-Hispanic blacks. Davis et al. (2017) found that Mexican-Americans infants and toddlers were more likely to be classified as overweight compared with non-Hispanic white and black infants and toddlers (P=0.002). Similar to this present study, Davis et al. (2017) indicated that disparities in overweight, feeding practices and mean nutrient intakes exist among infants and toddlers according to race and ethnicity.

In the present study, in addition to the duration of breastfeeding, the type of infant feeding was linked to the risk of obesity between the child's second and fifth birthday, with the highest rate of obesity (30.2%) observed among Hispanic participants who were fully formula fed, followed by Hispanic infants who were partially breastfed (28.9%). Among Hispanics, the infants who were exclusively breastfed had the lowest obesity rate (21.9%). Similar findings were observed among non-Hispanic participants, where the highest rate of subsequent obesity between the ages of two and five were seen among infants who were fully formula fed (21.3%) or partially breastfed (18.7%). The lowest rate of obesity was seen among non-Hispanics who were exclusively breastfed (14.6%).

Appleton, Russell, Laws, Fowler, Campbell & Denney-Wilson (2018) explored supporting evidence for a range of formula feeding practices associated with rapid weight gain (RWG) in infancy. Researchers examined formula feeding practices that may increase the risk of formula fed infants experiencing RWG based on the three pathways of nutrient profile, mode of delivery, and parents' feeding practices. There is limited evidence identifying and associating formula feeding practices with RWG in infancy and further studies are needed before firm recommendations can be made. The IFPS II found that majority of infants (59.3%; n=200) were formula fed after birth, with the percentage increasing to 67.5% by 6 months of age (CDC, 2017). Most of the infant-feeding research focuses on identifying mother's reasons for the cessation of breastfeeding; as a result, the experiences of mothers who choose to use formula is largely overlooked in quantitative designs (Fallon et al., 2016).

Many studies had shown an association between initiation of complementary feeding (i.e., solid food) and breastfeeding duration. Multiple factors including lack of knowledge about breastfeeding, unsupportive cultural and social norms, poor family and social support, and unsupportive work and childcare environments restrain mothers' breastfeeding goals (Anstey et al., 2017).Lindsay et al. (2017) noted that early introduction to complementary foods and a decreased of breastfeeding duration are practices associated with an increased risk of unhealthy weight status and obesity in early childhood. Feeding practices such as duration of breastfeeding and timing of introduction to complementary feeding have been described to impact early growth and subsequent overweight and obesity (van Eijsden et al., 2015). The WIC Infant and Toddler Feeding Practices Study 2 (WIC ITFPS-2): Second Year Report, a longitudinal study designed to measure the feeding practices, found that 16% of participants had started feeding complementary

foods at 3 months; the number increased to 65% at 5 months (65%) and 95% at 7 months (Borger, Weinfield, & Zimmerman, 2018).

Family and culture emerged as important influences on mothers' infant-feeding beliefs and practices. Similarly, factors such as personal attitudes and beliefs, as well as family and cultural influences have been linked to have a relevant role in the timing of introduction to complementary feeding (Kuo et al., 2011; Lindsay et al., 2017; van Eijsden et al., 2015). Another significant factor is ethnicity since complementary feeding practices have been shown to differ among ethnic groups (Ahluwalia et al, 2012). However, limited research is available that discusses the impact of attitudes, beliefs, and practices regarding complementary feeding and obesity among Hispanics.

Predicting Childhood Obesity by Infant Feeding Practice

In this current study, when ethnicity (Hispanic versus Non-Hispanic), breastfeeding duration in months, and IBE versus IBP were included as predictor variables in the logistic regression analysis, the odds ratio (OR) of becoming obese at any time between a participant's second and fifth birthday increased by 38% if the child was Hispanic (OR = 1.383, [95% CI: 1.076 – 1.777], p=0.011). Similarly, the OR of obesity increase by 26.7% if an infant was partially breastfed (IBP) (OR = 1.267, [95% CI: 1.177 – 1.365] $p < 0.001$). Lastly, it was observed that for each month of breastfeeding, the OR of obesity dropped by 1.5% (OR = 0.985, [95% CI: 0.980 – 0.990], $p < 0.001$).Similar findings were reported by Whaley et al. (2017) who found that every additional month of full breastfeeding resulted in a 3% decrease in the odds of obesity between the ages of 2 to 5 years.

In the United States between 2011 and 2014, NHANES data indicated the prevalence of childhood obesity in children and adolescents aged 2-19 years was 17% or 12.7 million children and adolescents (Ogden et al., 2015). Hispanics were more likely to be obese than to non-Hispanics, with the prevalence of childhood obesity 21.9% among Hispanic compared to 19.5% among non-Hispanic blacks and 14.7% among non-Hispanic whites (Ogden et al., 2015). Findings from this study concurred with national findings that have found the risk of developing childhood overweight or obesity is highest among minority groups (van et al., 2015).

In a longitudinal study, Chiasson et al. (2016) examined the relationship of feeding practices, behaviors, and demographics to BMI among children enrolled in the New York State WIC program as infants and retained in the program until their third birthday. It was observed that by age 3, 15.1% of the children were obese, with the rate of obesity at 3 years of age lowest among those participants whose mothers received the full breastfeeding food package, similar to the present study where it was observed that for each month of breastfeeding, the OR of obesity dropped by 1.5%.

Findings from this current study showed that the odds of obesity increase by 26.7% if an infant was partially breastfed (IBP). This finding suggests the importance of awareness of infant feeding practices. Moss & Yeaton (2014) found that children who were not breastfed had decreased odds of being obese when complementary feeding introductions were postponed until 4 months, and the odds of being obese were further reduced when complementary feeding delay was combined with breastfeeding. These findings indicated that breastfeeding and delaying complementary feeding introduction have a positive impact on weight status, at both 2 and 4 years. Research has shown that factors such as personal attitudes and beliefs, as well as family

and cultural influences to have a relevant role in the timing of introduction to complementary feeding (Kuo et al., 2011; Lindsay et al., 2017).

Lindsay et al. (2017) reported that, for mothers, WIC was an important source of information related to infant-feeding practices, including exclusive breastfeeding and appropriate introduction of solid foods during their pregnancies. Similarly, Chiasson et al. (2016) mentioned that studies have shown that breastfeeding initiation increases after WIC peer counselor contacted participants.

Understanding how early dietary practices relates to weight status in infants may help to develop programs to prevent obesity later in life (Sinigaglia et al., 2016). In a qualitative study in South Africa, Nor et al. (2012) emphasized the need to consider and identified the strong cultural beliefs that promote mixed feeding, in order to decrease barriers to exclusive breastfeeding. In addition, Fallon et al. (2017) indicated that researchers have suggested that current breastfeeding recommendations "one size fits all" is an unachievable approach that disregards individual women's circumstances. This is congruent with the findings of this study as breastfeeding duration differed among ethnicity (Hispanic and non-Hispanic) of participants.

Additionally, Fallon et al. (2017) argued that current literature suggest that policy makers are encouraging idealistic expectations in pregnancy but failing to support women to achieve these goals after birth. Therefore, programs supporting breastfeeding and increasing awareness among women are key to increase breastfeeding rates. Currently, hospitals are implementing the BFHI which recommends good health practices that support breastfeeding and increase likelihood of optimum breastfeeding among lactating women, and the use of lay health workers such as home-based peer counselors as strategies to increase the rate of exclusive breastfeeding (Mathur & Dhingra, 2013; Nor et al., 2012).

Summary

Over the years, interest in infant feeding practices have arisen as they have been perceived as factors influencing weight status and body composition. The recommended, and preferred method of infant feeding continue to be breastfeeding. Breastfeeding have been shown to have positive health outcomes for both mother and infant. Breastfeeding rates among WIC participants between 2008 and 2012, indicated only 64.7% were ever breastfed. Breastfeeding duration differed among participants, which affected weight status and significantly varied according to ethnicity. Overall, the results of this study suggest infant feeding practices may influence weight status of children participating in WIC. The present study identified disparities among Hispanic, and non-Hispanic participants in which Hispanic participants were highly prone to become obese compared to non-Hispanics. For each month of breastfeeding, the odds of becoming obese were shown to decrease among children. Thus, tailored infant feeding recommendations which highlights the benefits of breastfeeding as recommended feeding method among women are needed.

CHAPTER 6

CONCLUSIONS, LIMITATIONS, AND RECOMMENDATIONS

The purpose of this study was to determine the relationship between infant feeding practices and the subsequent classification of obesity among Hispanic and non-Hispanic children 2- to 5-years of age served by the WIC program in Indiana between 2008 and 2012. This chapter summarizes the results of the study, identifies the study's strengths and limitations, and presents ideas for future research.

Conclusion

Childhood obesity is an increasing public health concern. The timing of the onset of childhood overweight, however, has not been well-examined (Mazarello Paes et al., 2015; Liu et al., 2015). Thus, preventing childhood obesity is a major national health priority (Davis et al., 2017). Health outcomes differ significantly by type of infant feeding practice implemented (Stuebe & Schwarz, 2010).The importance of the role of infant feeding practices and weight status are an emerging area of research. Davis et al. (2017) noted that identifying feeding practices in infancy could prevent severe consequences such as the onset of overweight.

Internationally, the recommended method of infant feeding is breastfeeding (Smith et al., 2016). Similarly, the AAP recommends exclusive breastfeeding for the first 4 to 6 months of age,

the introduction of solid foods at 4 to 6 months of age, continued breastfeeding to the first birthday and beyond if possible, and the use of infant formula for the first year of life for those infants who are not breastfed (Kleinman, 2014).Furthermore, understanding the complexity of infant feeding choices and the significance of factors such as social, cultural forces, age, and ethnicity is essential (Head, 2017).

One of the main goals of this study was to determine the relationship between method of infant feeding and the risk of obesity among 2- to 5-year olds served by WIC in Indiana between 2008 and 2012. It was found that 21.6% of participants were considered obese at least one time between their second and fifth birthday. Breastfeeding rates among participants were lower than national goal, in this study only 64.7% of participants were ever breastfed, and a significant percentage of participants, 35.5%, were never breastfed.

When duration of breastfeeding was compared, results indicated that participants who became obese were breastfed for shortest periods of time, compared to those participants who never became obese (2.8 ± 5.6 months vs. 3.5 ± 6.4 months, $p < 0.001$) respectively. This study examined the type of infant feeding practice (i.e., fully breastfed, partially breastfed, or fully formula fed), results showed that majority of participants (70.2%) were fully formula fed. According to the type of infant feeding practice participants who were partially breastfed (IBP) had the highest obesity rate 23.2%, whereas those participants who were exclusively (IBE) showed the lowest obesity rate with only 15.9%.

In addition, this study determined if there was any difference in the relationship between method of infant feeding and the risk of obesity among children aged two to five years served by WIC. It was observed that Hispanic participants who were never breastfed had higher obesity rates than any other participant. The longest duration of breastfeeding in months was also

observed among Hispanics, with a mean duration of breastfeeding in months of 5.4 ± 7.5 months. Hispanic participants that were fully formula fed represented the highest percentage of obesity observed, compared to other groups. Interestingly, among non-Hispanics who were partially breastfed higher obesity rates were observed among this group.

Furthermore, logistic regression analysis indicated there is a 16.3% probability a WIC participant will become obese at any time between their second and fifth birthday. The present study showed disparities in feeding practices and the subsequent onset of childhood obesity among participants. It was found that odds of becoming obese at any time between participants' second and fifth birthday increased by 38% if the child was Hispanic. When examined by infant feeding method, being partially breastfed increased the odds of becoming obese by 26.7%. This study showed that for each month of breastfeeding, the odds of becoming obese dropped by 1.5%. Similar findings have been described by Whaley et al. (2017) who reported that breastfeeding contributed to reductions in the development of childhood obesity, and that initiating breastfeeding was associated with reduced obesity between the ages of two to five years, particularly when no formula was introduced.

Overall, the results of this study contribute to the emerging research aiming to determine the relationship between infant feeding practices and the subsequent odds of childhood obesity. The present study is the first research study to analyze WIC data in Indiana. Findings suggest disparities in overweight by ethnicity, and displayed differences among infant feeding method.

Strengths and Limitations of the Study

The primary strength of this study is the large population size assessed. The data for this secondary analysis was collected from trained Nutritionist and Dietitians serving WIC

participants in Indiana. Another strength was the collaboration of a statistician who analyzed data. This study categorized infant feeding practices into three main categories (i.e., infant exclusively breastfed, infant partially breastfed, infant formula fed), and compared groups according to ethnicity in order to identify the relationship between infant feeding practices and the subsequent odds of becoming obese.

However, when reading results from this study several limitations must be considered. First, the data reviewed is secondary data. This meant the researcher was limited in the number and type of variables that were available to be included in the analysis. Human error may have occurred while reporting participant's information (i.e., weight, length) in WIC visits. In addition, WIC does not limit to select only one racial group, and one ethnic group category selection during enrollment, resulting in doubtful multiracial and multiethnic participants as it was observed in this analysis. This secondary data analysis was a cross-sectional study; therefore, the results do not represent causation. Lastly, the accuracy of the data must always be in the mind of the researcher, as the length and exclusivity of breastfeeding was self-reported.

Recommendations for Future Research

Based on the results of the present study further research on the relationship of infant feeding practices and childhood obesity among WIC participants is warranted. The following suggestions are recommended based on the results of this study:

- Analyze additional variables that may affect children development and determine how environmental and social factors may influence children weight status and feeding habits.

- Develop longitudinal studies to evaluate and compare findings of studies examining infant feeding practices and weight status among infant and children served by WIC, and particularly, analyzing several years to distinguish trends.
- Analyze specific age groups, race and ethnicity of WIC participants to evaluate how infant feeding practices play a role in the early onset of childhood obesity.
- Limit race categories available in WIC enrollment questionnaire to only 5 main categories (American Indian or Alaskan Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, and White),with an additional category "other," for those with multiple races, and to further analyze participants' own perception of their race.
- Develop a WIC enrollment questionnaire which asks to choose ethnicity, and if appropriate to further analyze race with an additional category "only Hispanic" for those participants who does not referred themselves as white, black or any other race category.
- The present study did not analyze the introduction a complementary feeding due to the inaccuracy of reported data. It would be beneficial for WIC to require an official reported date of complementary feeding initiation among WIC participants.
- The current study is only relevant to the state of Indiana and only represents low income families participating in WIC in other states. Additional studies among including other socioeconomic groups are warranted.

Summary

The aim of this study was to determine the relationship between infant feeding practices and the subsequent odds of becoming obese among children aged two to five years served by

WIC program in Indiana between 2008 and 2012 by race and ethnicity. While the causes of obesity are known to be multifactorial, this study only focused on the relationships between infant feeding method (exclusive breastfeeding, partial breastfeeding, and formula feeding) and the subsequent risk for obesity between the ages of two and five yearss among Hispanic and non-Hispanics. A significant percentage, 21.6% of participants were considered obese, and were breastfed for shortest periods of time compared to other participants. The most common feeding practice was formula feeding. In contrast, breastfeeding rates among participants were lower than national goal, and Hispanics were found to breastfed for longer periods of time. Hispanic participants who were never breastfed had higher obesity rates than any other participant. In addition, it was found that odds of becoming obese increase by 38% if the child is Hispanic. In contrast, for each month of breastfeeding, the odds of obesity dropped by 1.5%. This study contributes to the emerging literature by examining infant feeding practices and the subsequent odds of becoming obese among WIC participants in Indiana. This will enable health professionals to promote appropriate and safe feeding practices among infants and children.

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APPENDIX A

INSTITUTIONAL REVIEW BOARD MATERIALS

A-1 IRB Letter of Exemption

A-2 CITI Certificate of Completion

Appendix A-1

IRB Letter of Exemption

Office of Research Integrity
Institutional Review Board (IRB)
2000 University Avenue
Muncie, IN 47306-0155
Phone: 765-285-5070

DATE:	February 6, 2018
TO:	Monica Sanchez, BS
FROM:	Ball State University IRB
RE:	IRB protocol # 1193380-1
TITLE:	Relationship between Infant Feeding Practices and Subsequent Childhood Obesity among Hispanic Infants and Children Served by the Special Supplemental Nutrition Program for Women, Infants and Children in Indiana: 2008-2012: A Comparison by Race and Ethnicity.
SUBMISSION TYPE:	New Project
ACTION:	APPROVED
DECISION DATE:	February 6, 2018
REVIEW TYPE:	**EXEMPT**

The Institutional Review Board reviewed your protocol on February 6, 2018 and has determined the procedures you have proposed are appropriate for exemption under the federal regulations. As such, there will be no further review of your protocol, and you are cleared to proceed with the procedures outlined in your protocol. As an exempt study, there is no requirement for continuing review. Your protocol will remain on file with the IRB as a matter of record.

Exempt Categories:

	Category 1: Research conducted in established or commonly accepted educational settings, involving normal educations practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
	Category 2: Research involving the use of educational test (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior
	Category 3: Research involving the use of educational test (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under category 2, if: (i) the human subjects are elected or appointed officials or candidates for public office; or (ii) Federal statute(s) require(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

X	**Category 4:** Research involving the collection of study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.
	Category 5: Research and demonstration projects which are conducted by or subject to the approval of Department or agency heads, and which are designed to study, evaluate or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in methods or levels of payment for benefits or services under these programs.
	Category 6: Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed or (ii) if a food is consumed which contains a food ingredient at or below the level and for a use found to be safe, by the Food and Drug Administration or approved by the Environmental Protection Agency or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

Editorial Notes:

1. Exempt Level Review

While your project does not require continuing review, it is the responsibility of the P.I. (and, if applicable, faculty supervisor) to inform the IRB if the procedures presented in this protocol are to be modified or if problems related to human research participants arise in connection with this project. **Any procedural modifications must be evaluated by the IRB before being implemented, as some modifications may change the review status of this project.** Please contact (ORI Staff) if you are unsure whether your proposed modification requires review or have any questions. Proposed modifications should be addressed in writing and submitted electronically to the IRB (http://www.bsu.edu/irb) for review. Please reference the above IRB protocol number in any communication to the IRB regarding this project.

Reminder: Even though your study is exempt from the relevant federal regulations of the Common Rule (45 CFR 46, subpart A), you and your research team are not exempt from ethical research practices and should therefore employ all protections for your participants and their data which are appropriate to your project.

D. Clark Dickin, PhD/Chair
Institutional Review Board

Christopher Mangelli, JD, MS, MEd, CIP/
Director
Office of Research Integrity

Appendix A-2CITI Certificate of Completion

APPENDIX B

LETTER OF PERMISSION

Appendix B – Letter of Permission

From: Mahari, Nona [mailto:NMahari@isdh.IN.gov]
Sent: Wednesday, September 27, 2017 1:30 PM
To: Friesen, Carol <cfriesen@bsu.edu>
Subject: RE: WIC Data

HI Carol,

I am working on your request. Before I dive deep in, wanted to make sure this is what you want.

You will get the following variables:

WIC ID – this will help you to determine whether the measurements belong to the same client
Category – IBE (infants breastfeeding exclusively)
IBP (infant breastfeeding partially)
IFF (infants formula fed)
Race/ethnicity
DOB
Gender
Date of measurement taken
Length in inches
Length in 1/8
Weight in pounds
Weight in ounces
BF duration in months (from the beginning to the end, not up to each measurement)
Date supplemental food began
Age of mom
Household size
Household income

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